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ECONOMIC GEOGRAPHY

APRIL

AGRICULTURAL REGIONS OF SOUTH AMERICA
Clarence F. Jones, *Economic Geographer, Clark University*

THE POTASH INDUSTRY OF EUROPE
Fred S. Mohme, *Geologist, University of Illinois*

THE SUGAR INDUSTRY OF THE BRITISH WEST INDIES AND BRITISH GUIANA WITH SPECIAL REFERENCE TO TRINIDAD
. Y. Shephard, *Professor of Economics, Imperial College of Tropical Agriculture, Trinidad*

RON AND STEEL INDUSTRY OF THE MIDDLESBROUGH DISTRICT
John W. Frey, *Geographer, University of Wisconsin*

THE GRAPE INDUSTRY OF SPAIN AND PORTUGAL
W. O. Blanchard, *Geographer, University of Illinois,* and Elizabeth R. Blanchard

THE PHILIPPINE LUMBER INDUSTRY
Luis J. Borja

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Dr. Jones, professor of economic geography at Clark University, contributes Instalment IV of "Agricultural Regions of South America." Dr. Jones returned in January from seven months of research work in northern South America, gathering material on the agriculture of this part of the continent. This study will be completed in the July and October numbers of ECONOMIC GEOGRAPHY.

Mr. Mohme was graduated from the department of geography of the University of Wisconsin in 1926, and in the following year he received the M.A. degree at the University of Illinois. The article on "The Potash Industry of Europe," appearing in this issue, was written by him while on the teaching staff of the University of Illinois. He later continued his studies at the University of Wisconsin.

Professor Shephard has been in charge of the department of economics at the Imperial College of Tropical Agriculture in Trinidad since 1924, and has contributed many articles, dealing with the development of tropical agriculture, to various periodicals, particularly *Tropical Agriculture*, the official journal of the college. He is at present engaged in a study of agricultural labor in Trinidad for which his "Economic Survey of the Cacao Industry of Trinidad," which appeared in ECONOMIC GEOGRAPHY, April, 1927, issue, and his present contribution on the sugar industry of the British West Indies, form a general economic background.

Dr. Frey, who was assistant professor of geography at the University of Wisconsin, is now in the Minerals Division of the Bureau of Foreign and Domestic Commerce. In 1925 and 1926 he was the secretary of a round table on "Mineral Losses in Their World Relations" (Chairman, Dr. C. K. Leith) at the Institute of Politics, Williamstown, Massachusetts. In 1927 he assisted Dr. H. Foster Bain in the preparation of the "Ores and Industries of the Far East." During the past summer he was engaged by the Bureau of Mines for research in mining laws of the world, a series which is being published by the Bureau of Mines as rapidly as completed.

Dr. Blanchard is associate professor of geography at the University of Illinois. He is author of "The Landes: Reclaimed Waste Lands of France," appearing in the April, 1926, number of ECONOMIC GEOGRAPHY; "White Coal in Italian Industry," in the April, 1928, issue of the *Geographical Review*, and of numerous other articles in the *Scientific Monthly* and the *Journal of Geography*, mostly relating to Europe. Mrs. E. R. Blanchard, his wife, was formerly an assistant in geography at the University of Wisconsin. Both made field studies in western and southern Europe in 1925.

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SOUTH AMERICAN TRADE

AS the new administration at Washington takes up the responsibilities of government for this land of ours, the most pressing problems that affect the prosperity of our people seem to arise from geographic and economic relationships—in large part, the adjustment of agriculture and other industries to the physical condition of the land and the needs of the people; the development of transportation, trade, and markets; and the coördination of the agricultural, industrial, and commercial resources and activities of the nation.

The increase of trade with Latin America appears to be one of the possible solutions for part of the problem. The exploitation of new lands, new mineral deposits, new raw materials of all kinds in Latin America, requires great increase of population and invested capital there; and the markets originating in the nations under the direction of which this activity is taking place should be one of the outlets for surplus American products. These markets must be gained by friendly contact, friendly service and coöperation, which are attainable only by deep understanding and appreciation.

No one is better qualified to promote this policy of friendliness than the trained geographer. He knows how different needs, different cultures, and different social organizations result from different relief, different climate, different location. He knows better how to interpret the lives of Latin American peoples in terms of American thought, than do most business men. He knows when to advance and when to withdraw. And so, in this one phase of the nation's problem, the solution will be much easier, if the trained geographer be consulted.

ECONOMIC GEOGRAPHY

VOL. 5 APRIL, 1929 No. 2

AGRICULTURAL REGIONS OF SOUTH AMERICA

INSTALMENT IV

Clarence F. Jones

Economic Geographer, Clark University

COFFEE AND GENERAL FARMING REGION

THOUGH lying almost entirely to the north of the Tropic of Capricorn, the Coffee and General Farming Region of southeastern Brazil owes agricultural prominence to a variety of products, the most significant of which, however, originate in the more temperate upland portions of the area. In addition to the production of coffee in central São Paulo and in the districts of Minas Geraes, Rio de Janeiro, and Espirito Santo, the acreage in corn, beans, rice, sugar, and cotton, and the significance of animal industries emphasize the suitability of the region for a number of agricultural products. Regional demarcation depends principally upon the areal distribution of coffee, sugar, cotton, and corn.

As a consequence of several factors favoring agricultural development, the region has acquired notable importance among the agricultural regions of the entire continent and a predominant position in Brazil, despite its relatively small area; it includes more than 60 per cent of the cultivated land of the entire country (Fig. 59). It embraces the principal population centers of Brazil, Rio de Janeiro, and São Paulo, the valuable areas of the plateau, and the less significant coastal agricultural districts with a density of population over much of its extent of from 40 to 160 inhabitants to the square mile. It has the second rail net in South America, which has exercised a profound influence on the spread of agriculture, notwithstanding the inadequacy of facilities in many sections. By reason of restricted navigability and direction of flow, rivers contribute little to facilitate agricultural expansion.

PHYSICAL CONDITIONS

The rolling plateau surface, averaging some 3,000 feet in elevation with the greatest height at the east, is reflected to a large extent in the localization of the principal crops. Interruptions to the broadly undulating surface of the major coffee areas are few. In the south, however, the Serra da Mantiqueira rises boldly above adjacent areas, as indicated in the distribution of cultivated land; and at the north, several ranges added to the relief of Minas Geraes. Well-drained and healthful, the upland favors cultivation and the growth of an energetic population. In contrast, the low coastal areas, generally unhealthful, serve chiefly to support ports handling

FIGURE 59.—The Coffee and General Farming Region, the Cacao Region, and the Cotton-Sugar Region of Northeast Brazil have nearly three-fourths of the cultivated land of the republic. (Statistics for all the Brazilian Maps compiled from *Recenseamento do Brazil, Vol. III (1a Parte)* pp. 389–425 and, *(2a Parte)* pp. 246–335, *Agricultura, Ministerio da Agricultura, Industria, e Comercio, Directoria Geral de Estatistica,* Rio de Janeiro, 1925).

plateau commodities or import trade, and to produce one important crop—sugar.

Variety of elevations, climates, and rocks has resulted in a number of important soils, ranging from the rich originally forested *terra rossa*, eminently suited to coffee culture, to the relatively infertile soils supporting *campos* vegetation developed in the sandstone and shale areas of the São Paulo plateau. The eastern coffee districts have developed on a third group of soils—heavy reddish clays, granitic and gneissic in origin, and inferior to the *terra rossa*. The western coffee lands on diabasic and other areas of eruptive materials possess great fertility; they contain abundant potash and have constituted the basis for the rapid rise of a Brazilian coffee industry. In general, either more productive coffee plantations or heavier tree growth marks the location of these soils.

In addition to a well-drained healthful upland and extensive areas of fertile soils, the major part of the region has a favorable climate. The generally heavily forested narrow strip of coastal lowlands and the seaward slopes of the plateau margin receive a rainfall of as much as 80 inches, in comparison with the average of 50 to 60 over much of the plateau; they experience the temperatures characteristic of their situation in subtropical latitudes, and have contributed less as a whole to agricultural advance in the region.

In the plateau portions, the seasonal distribution of rainfall has fostered materially the spread of coffee culture, in that much of the precipitation takes place in the spring and summer and that the pronounced dry season of autumn and winter facilitates the proper preparation of the berries. Corn, cotton, and rice profit equally by this period of bright sunny weather. On the other hand, the production of sugar cane indicates the greater uniformity of seasonal rainfall, of relative humidity, and of high temperatures in the coastal areas.

Less favorable over all of the region are temperatures. Occasional frosts may occur, though on the whole, winter temperatures average some 60° to 65° F. As a consequence, plantations have become grouped in the upland districts at elevations between 1,800 and 2,500 feet above sea-level while the valleys, subject to the cold resulting from temperature inversions, have undergone little agricultural transformation. Summer temperatures may rise above 100°, but in general extremes are not common; those of the upland surpass those of the coastal area; less intense insolation in higher

latitude contrasted to the other coffee lands of Tropical America obviates the necessity for shading coffee trees.

AGRICULTURAL PRODUCTS

Though the Coffee and General Farming Region includes one of the major corn-producing areas of the world, supports relatively important production in beans, rice, sugar, and cotton, and has developed large grazing industries in cattle and swine, coffee possesses economic significance to Brazil excelling by far that of all other regional interests combined (Table IV); it occupies 23 per cent of the cultivated land of the region.

TABLE IV*

LAND IN CROPS (1920)

(Thousands of acres)

	São Paulo	*Minas Geraes*	*Rio de Janeiro*	*Espirito Santo*
Cultivated land	4,712	3,275	712	537
Coffee	2,460	620	485	380
Corn	1,332	1,292	145	130
Beans	460	265	42	20
Rice	497	195	20	12
Sugar	71	281	53	28
Cotton	246	11	1	1
Cassava	21	17	20	13
Potato	15	4	2	..
Wheat	7	...	5	7

* Compiled from *Recenseamento do Brazil, Vol. III (2a Parte)* pp. 246–335, *Agricultura, Ministerio da Agricultura, Industria e Comercio, Directoria Geral de Estadistica*, Rio de Janeiro, 1925.

THE COFFEE INDUSTRY

A growth of less than a century, the production of coffee in Brazil has furnished the country the bulk of its export trade since 1840. In early days, however, principal agricultural activity in the region centered upon corn and sugar for local consumption, and upon cattle for some degree of export; the important districts lay in southeastern São Paulo, including the upper valley of the Parahyba River and the land about Campinas, and in southeastern Minas Geraes. Following a period of comparatively slow, though prosperous, expansion, the production of coffee entered an era of unprecedented activity in the 1880's, arising from the realization of the several factors favoring the culture of the plant. *Fazendas* sprang up in large numbers; colonization by Italians, to replace the emancipated slaves, increased enormously; and systematically the *terra rossa* soils came into cultivation. The three coffee subregions became defined: (1) central São Paulo, upon the red or purplish soils proper, (2) the coastal foothills and spurs of the Serra do Prantiqueira and neighboring coastal highlands, (3) southeastern Minas (Fig. 60).[1] In the early years of the twentieth century, Brazilian coffee, of which the region produces practically all, had become the leading export commodity of South America.

Suitability of Region for Coffee Culture

Both from the standpoint of physical suitability and of consequent conditions of human culture, the region provides a land highly adapted to the production of coffee. Rolling topography provides air drainage and soil aeration. Deep fertile plateau soils, of high iron and potash content, contribute additionally to the production of a coffee of superior flavor. So extensive are the areas of excellent soils, that the common practice following impoverishment consists merely of abandonment or planting to other crops and the reëstablishment of the coffee plantings on a new site cleared of forest growth.

The dry, sunny, warm weather favors the harvesting, washing, and drying processes. In contrast to the

[1] The author is indebted to Mr. Charles Gooze for valuable assistance in the preparation of the fourth instalment of *Agricultural Regions of South America*, and to Miss Mabel Ripley for assistance in the distribution of dots of acreage and animal statistics by *Municipios*, on the Brazilian maps.

need for several pickings in other regions, berries here ripen practically simultaneously. The healthfulness of the region permits the growth of an energetic population. Immigration, the development of rail transport following the boom years subsequent to 1885, and governmental aid have enhanced further the adaptability of the region to the industry. The one railway from the coffee region to Santos, however, in addition to imposing the handicap of a monopoly upon the region, now becomes inadequate to handle the increasing volume of traffic. Difficulties of construction in the rugged country connecting plateau and coastal plain may delay establishment of a government-owned railway for many years. An additional factor conditioning coffee culture, now checked to a certain extent by valorization and the diversification of crops, lies in the tendency towards overplanting and consequent overproduction, an outgrowth of unusual physical suitability and mode of land tenure.

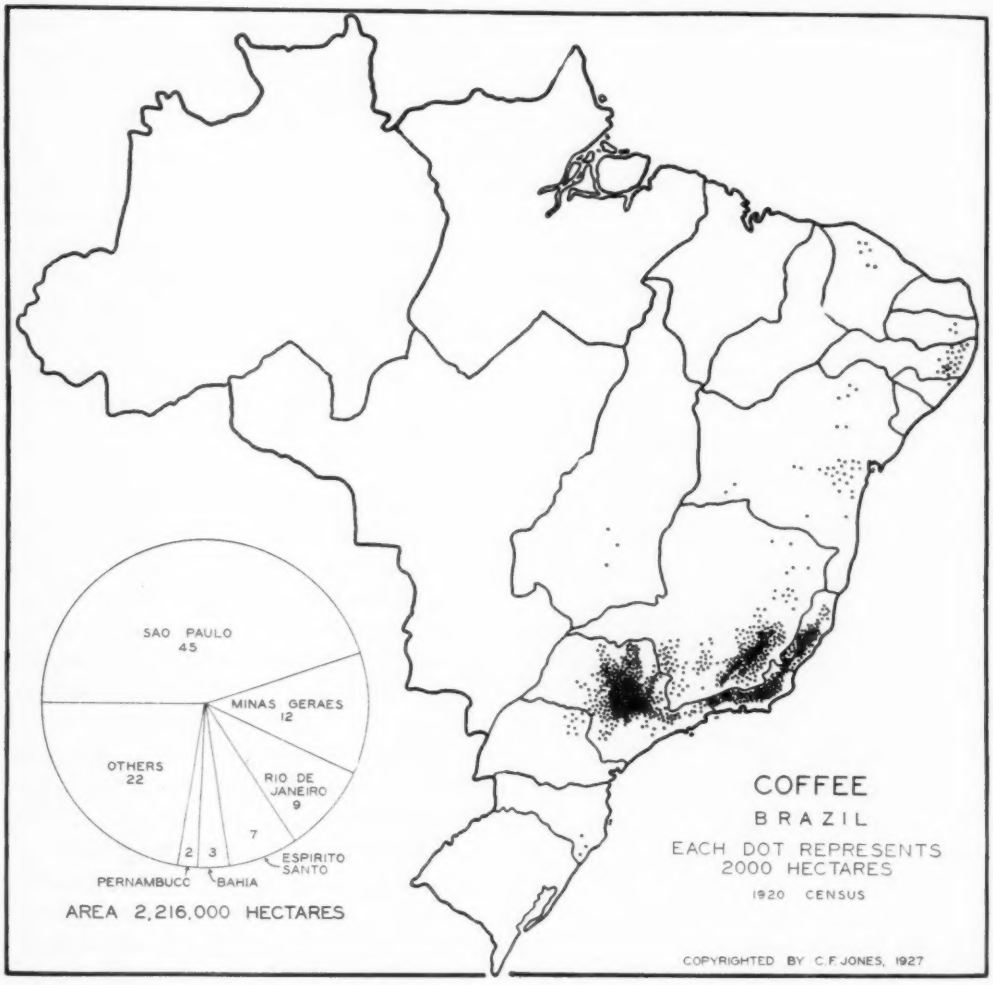

FIGURE 60.—The rolling surface of the highlands of the central part of Brazil affords almost ideal conditions for the cultivation of coffee.

Methods of Coffee Culture

As a result of the quantities of hand labor required, the number of processes preliminary to shipment of the beans, and the need for considerable capital, the coffee-producing lands support extensive *fazendas*—a situation well-adapted to coffee culture, but one which hinders diversification of agriculture as has proved the case with the *latifundia* system on the *estancias* of Argentina.

Living in villages on the *fazenda*, in one case with a total population of 8,000 on the estate, immigrant labor cultivates the crop. In general, each colonist receives an allotment of some two thousand trees, representing an area of five to seven acres. With almost two billion trees set out in the states of São Paulo, Minas Geraes, Rio de Janeiro, and Espirito Santo, the demands for labor become a serious problem. Because of the abundant rains of summer and the resultant prodigious growth of weeds on the fertile soils, the laborer during the season of cultivation is engaged principally in weeding. The colonist receives a stipulated sum of money and the privilege of growing corn and beans, staples of his diet, between the rows of young coffee trees, previous to their period of bearing which begins in the fourth year. In recent years the labor situation has changed considerably and the spread of machinery for use on *fazendas* increases. Contributing factors include the competition for labor introduced by the rapid urban growth of the city of São Paulo, and the attractions of higher wages and more favorable rates of exchange in Argentina.

Such drainage of labor supplies becomes more dangerous in the harvest season, for hand labor only can provide for picking the berries. This period in the transference of incipient fruit to dried bean commences generally in late June; owing to the well-defined seasons, the entire crop reaches maturity almost at the same time, a feature conducive to quality of product but necessitating larger forces of labor than would be the case in a more prolonged ripening interval as in some of the other coffee regions of Tropical America.

Removal of skins and pulp, washing and drying, and sorting of beans prepare the crop for sacking. In the process of drying, particularly, regional advantages for coffee culture become evident. The blackened tiles of the drying-grounds or *terreiros* acquire intense heat under the blazing sun and cloudless skies of the winter season. In addition, low relative humidity and frequent gentle winds promote evaporation. Occasionally, however, conditions prove less auspicious. The drying period may vary from a few days to weeks. Constant watch is kept of the weather and canvas covers customarily protect the beans against rain or high wind.

The net result of the manner of production arising from the physical conditions of the region is indicated in the growth of Brazilian coffee production, in recent years representing 65 per cent of the world crop. The phenomenal rise in coffee shipments derived its stimuli from the destruction of the coffee industry of Ceylon by the blight, the growing consumption of the beverage in the United States and northwestern Europe, and the stupendous scale of planting on the coffee lands of São Paulo (Fig. 61), which set the stage for the difficulties of the Brazilian coffee industry of the twentieth century.

Valorization of Coffee

The basis for the first coffee crisis lay in the method of remuneration to colonists. Under this system the cultivator managed the land for five years, at the end of which period he returned it to the owner with the coffee trees in bearing. The colonist received a small fixed sum of money and the crops which he raised during those years; in order to retain his laborers the planter was obliged to continue setting out trees. So that shortly the number of trees and the production of coffee grew out of all proportion to the demands. From 1896 to 1906 world production increased from 10,000,000 to 23,800,000 bags; in the latter year there existed a reserve from previous crops of 11,500,000 sacks. In order to avert a disastrous crisis the government intervened in the market and bought 8,500,000 sacks, which were warehoused and sold later at a profit. Because Brazil dominated the world in coffee exports, the withdrawal of this huge amount of coffee from commercial channels forced the price of coffee in world markets to rise.

Variability in world markets, the difficulty of curbing planting in the region, and the expansion of the industry in competing lands caused resort to governmental aid in 1917, 1921, and again in 1922, a policy fundamentally detrimental to the economic status of the region in that it encouraged additional planting of coffee and discouraged diversification of crops. Also, the government began to restrict shipments of coffee to Santos by erecting nine warehouses in the interior of the country where coffee was stored to await shipment. This regulated the market and took the control of coffee out of the hands of growers. Before valorization was practiced, 85 per cent of the coffee reached Santos within six months after harvest; now it must be stored in government warehouses in the interior and is released only by official order.

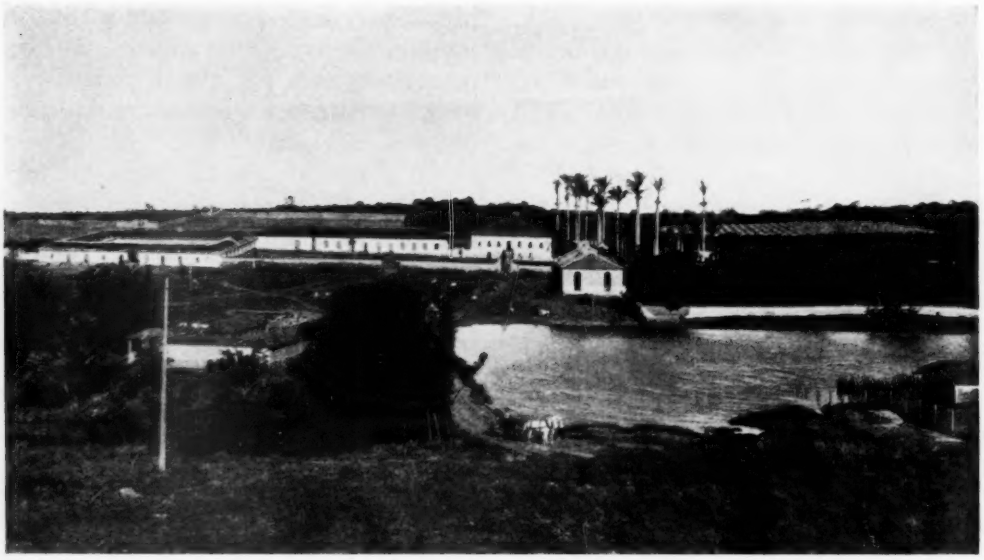

FIGURE 61.—In the rolling plateau of São Paulo are 1.18 billion coffee trees with space for 5 billion more. *Fazenda* "Lapa," Campinas, São Paulo. (Courtesy of Publishers Photo Service.)

The final step has been the organization in São Paulo of the Institute for the Permanent Defense of Coffee, which makes loans to planters on easy conditions, regulates deliveries to Santos, purchases coffee for retention from market, and collects taxes for carrying on propaganda to increase foreign consumption of Brazilian coffee. After repeated attempts the São Paulo Institute for the Permanent Defense of Coffee succeeded in 1928 in getting the growers of Rio de Janeiro, Espirito Santo, Minas Geraes, and Goyaz to coöperate fully in the various functions of the Institute.

Valorization has repeatedly bolstered up the price of coffee and saved *fazendeiros* from ruin in times of special stress, but it cannot relieve permanently the financial stress of overproduction. In late years large agricultural interests have become aware of the dangers of a one-crop economy and of the exceptional advantages of the region for crops other than coffee—a movement furthered by the growth of industry in

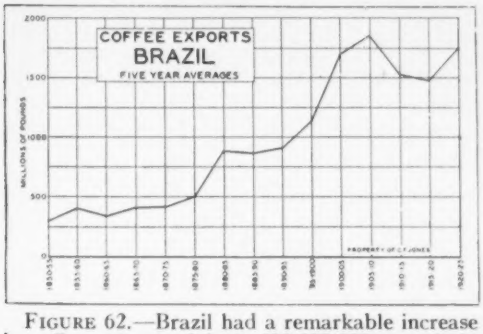

FIGURE 62.—Brazil had a remarkable increase in coffee exports of from 300,000,000 pounds in 1850–1855 to 1,850,000,000 in 1905–1910, the high-water mark in the coffee trade. The first crisis in the industry came in the dacade 1900–1910 with overproduction and the decrease in the price of coffee.

Brazil and the recent infestation of more than 200 million trees in the State of São Paulo by *stephanodores*, a destructive plant pest (Fig. 62).

The coffee regions need an improvement in the types of machinery used, thus lowering the cost of production and offsetting the shortage

FIGURE 63.—The chief areas of rice culture in Brazil lie in the western part of the Coffee Region in São Paulo, in the coastal plains of the southeastern part of that state and in east central Rio Grande do Sul.

of labor; a diversification of crops in the coffee regions, thus affording a better use of labor and machinery, and reducing proportionately the cost of farm operations now charged to coffee; careful inspection service to prohibit the shipment of coffee by growers who do not fumigate coffee infested with *stephanodores* and who do not clean up infested plantations; the breaking of the São Paulo Railway concession, which prohibits any other road from Santos to São Paulo, thus relieving in part the transportation congestion where the whole railway net of São Paulo focuses on the single line from that city to Santos; and the adoption of certain measures to reduce further the cost of production, thereby aggressively meeting competition from other areas and capitalizing on the exceptional advantages enjoyed by the coffee industry in Brazil.

MINOR CROPS

Ease of production and high degree of utility as food render corn the second crop of the region, with an acreage 80 per cent as large as that in coffee. Practically all of the corn remains within the region for use in the daily meals of the lower classes. from the relatively dry ripening and harvesting period.

Cultivated like corn in all parts of the region, and on every *fazenda*, beans of a black variety enter into daily diet among the poorer classes; also they are eaten with rice, corn, and other foods. In many cases both corn and beans grow in the same

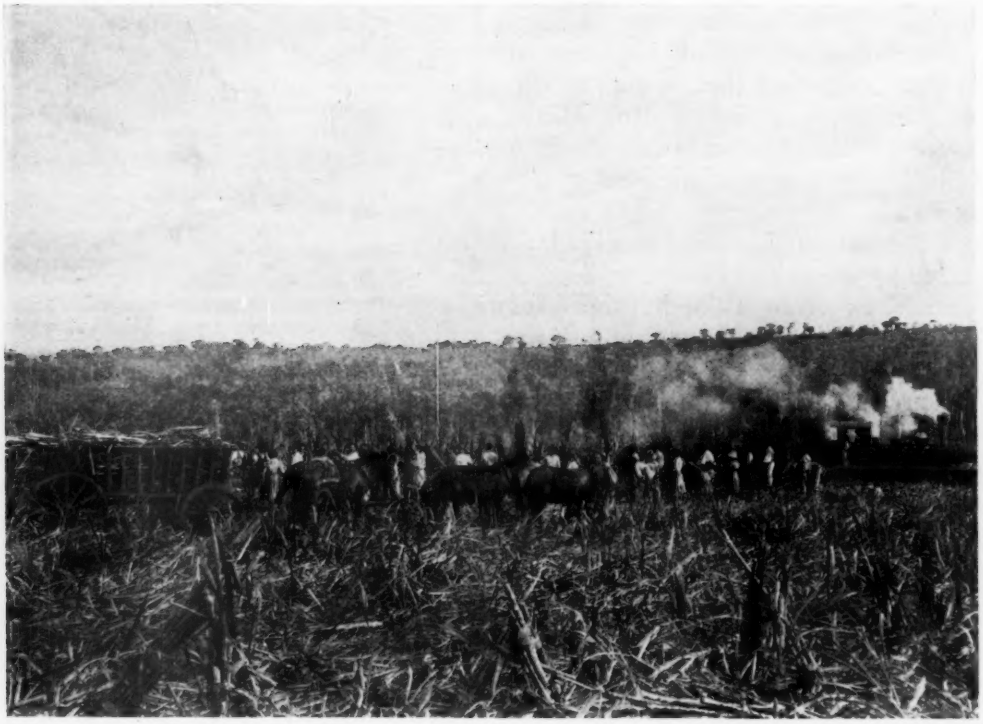

FIGURE 64.—Harvesting sugar cane, another crop that assumes a significant place in the agricultural economy of the Coffee and General Farming Region. (Courtesy of the Pan American Union.)

Primitive methods characterize its cultivation over most of the region although in accord with general progress in agriculture improved methods have been introduced; a good pioneer crop, corn provides the usual first crop on recently cleared and burned-over lands. Later, it may be cultivated between rows of young coffee trees. Like coffee, the crop thrives under the well-distributed rainfall of the growing season and secures similar benefits for storage field, often on abandoned coffee plantations, the corn plant furnishing the bean a support upon which it may climb. Considerable possibilities for the rehabilitation of exhausted agricultural lands lie in the nitrogen-fixing capabilities of the legume, but as yet, abundance of rich new lands and disinclination of large-scale producers sustain an unprogressive regard towards the use of fertilizers.

Third among the important food crops, rice has furnished a profitable

means for the diversification of agriculture. Although a small production of lowland rice characterizes coastal and river valley districts, the crop, chiefly of the upland type, has assumed prominence in the region, more particularly in districts settled by Japanese. With a major concentration in northern São Paulo, rice has spread markedly in recent years, for it constitutes the staple food in many districts, and is exported in considerable quantities (Fig. 63).

FIGURE 65.—A field of cotton in the Coffee Region of the State of São Paulo. This crop has meant much to coffee producers hard hit by overproduction and *stephanodores*. (Courtesy of the Pan American Union.)

In early days an especially valuable crop in the lower Parahyba Valley in Rio de Janeiro, sugar has advanced into the plateau districts of eastern Minas Geraes and central São Paulo. In addition to sufficient rainfall and fertile red soils of the plateau and clay alluvial soils of the "campos," the region affords several favorable factors. As a crop succeeding coffee on the plateau, it thrives exceedingly well; the careful preparation and weeding of the land needed for coffee provides exceptionally fit conditions for the cultivation of sugar (Fig. 64). The large local population assures a ready market. The exportation of surplus production, however, in competition with other regions proves difficult. As a rule, primitive methods of cultivation prevail and the majority of the mills operate with long antiquated equipment.

Though a minor crop in acreage, cotton has occasioned major interest as a possible cash crop other than coffee (Fig. 65). Much less developed than that in the Cotton-Sugar Region of Northeastern Brazil, the cotton-producing industry here localized in central São Paulo, has

opportunities for notable growth. The American upland cotton yields a one-inch fiber as grown in the region and suffers by comparison with the long-staple tree cotton of the northern area; on the other hand it is an appropriate crop for the coffee lands. insufficiently pronounced less rainy season. The crop may be planted between rows of coffee trees, and in many districts its small labor requirements as compared with coffee favor its establishment as a principal crop. Proximity to large centers of

FIGURE 66.—Found in all parts of the republic where people dwell cattle are especially numerous in the eastern and southern part of the country. Primarily beef cattle in the south and in the *Campos*, they serve as the chief draft animal in the Coffee, Cacao, and Cotton-Sugar Regions.

Soils and distribution of rainfall prove distinct benefits; cotton profits as much from the fortunate autumn dry season as coffee; the absence of cotton cultivation in the coastal sections indicates the effect of an population and the growth of the Brazilian cotton-manufacturing industry enhance further the fitness of cotton as a crop in the region; in order to attain considerable importance in production, agricultural and

FIGURE 67.—A herd of select native breeding cows in the central part of the Plateau of São Paulo. (Courtesy of the Pan American Union.)

marketing methods necessitate great improvement.

FIGURE 68.—A stock farm on the Plateau of São Paulo, showing the typical native long-horned and rough-boned cattle; in the distance a typical forest of the eastern part of the Plateau. (Courtesy of the Pan American Union.)

Relatively unimportant in acreage and as articles of diet, cassava, the potato, and wheat augment the list of food crops. Highly productive and easily cultivated, cassava provides the principal starch food for much of the region, notably in the lowlands of Rio de Janeiro and

Espirito Santo. Lower temperatures and less abundant rainfall, however, restrict its production in the plateau and encourage the cultivation of potatoes instead. At the same time, temperature is too high and rainfall too great for profitable culture of wheat.

REARING OF LIVESTOCK

While the livestock industries of the Coffee and General Farming Region are markedly subordinate to cultivated crops, they possess much significance in feeding the 14 millions of inhabitants in the region, in contributing to the utilization of extensive areas of *campos* grasslands in southern Minas Geraes which lie at an elevation too great for coffee culture (largely over 3,000 feet above sea level), and in furnishing power for cultivation (Fig. 66).

At present comprising some 20 per cent of all the cattle in Brazil, the cattle industry of this region has experienced a long evolution from the time that it was the leading industry in the days of frontier settlement in São Paulo. Though a large portion of the seven million animals is used chiefly for draft purposes, the growth of population has caused a corresponding increase in the production of meats, especially in the districts which grow relatively little coffee (Fig. 67). Moreover, as in the Great Plains-Corn Belt population center movement of cattle in the United States, there exists a flourishing area about São Paulo City devoted to the fattening of cattle from the Campos Grazing Region, either for local consumption or for shipment abroad. The industry as a whole promises much growth; mild climate permits open winter grazing, forage is available throughout the year, transportation facilities surpass those of other parts of Brazil, and large domestic and foreign markets offer numerous opportunities (Fig. 68). The cattle are inferior to Argentine animals, but the introduction of pure-bred Hereford and Shorthorn stock has progressed rapidly in recent years, ranges have been fenced, foreign capital has become interested, and steps have been taken to reduce the ravages of insect pests and diseases.

Density of population, ease of production on a small scale, and urban markets account for some seven and one-half million swine raised in the region, in the main in those districts supporting the major concentrations of cattle. The animals, fed on corn and allowed to root for a living in the woods, afford a local meat supply and contribute to the exports of the region. Thin, large-boned, and fattened with difficulty, the stock offers many opportunities for progressive development.

AGRICULTURAL OUTLOOK

Preëminence of the Coffee and General Farming Region among the several agricultural provinces of Brazil derives its bases from factors which will assure continuance of the present significance of the area for a long period. In a region which with respect to healthfulness over an extensive area suitable for agriculture probably excels any other region of the world in similar latitudes, the growth of population, based upon European stocks and the consequent development of agriculture, transportation, and manufactures augur well for the future. Though the power exercised by Brazilian coffee in world markets indicates prolonged predominance of the crop in the region, diversification in crops has

been effected. The spread of multilateral interests in agriculture will contribute materially not only to the capability of the region for meeting the requirements of its own inhabitants, but also in an enhanced degree to its potentialities as a source of a variety of agricultural commodities for world markets.

EASTERN COASTAL FOREST

The Eastern Coastal Forest Region stretches along the east coast of Bahia from 18° S. to about 12° S. and extends inland from 10 to 80 miles, from the coastal lagoons and swamps to an elevation of nearly 3,000 feet in the southern part and to the valleys and lower slopes of the central portion, where the forest has given way to cacao plantations.

RELIEF AND SOILS

The relief and soils of the region present a variety of conditions. The portion south of the Bay of All Saints consists of two parallel belts. Bordering the coast is a narrow belt of unconsolidated alluvial and marine sediments of rather recent age. These under the influence of a humid tropical climate have given rise to strips of clay and sandy soils of varying degrees of fertility. Much of the plain consists of sandy ridges and marshy stretches. To the west rise the Serra do Mar composed chiefly of ancient granites and metamorphic rocks, especially gneiss and mica-schists, which have developed under the rainy hot climate a deep heavy brown to red soil. Rolling to rough lands, the ranges of the Serra do Mar in this latitude are broken by several major streams, including the Mucury, Jequitinhonha, Prado, and Rio de Contas. Around the Bay of All Saints lies a zone of low rolling hills

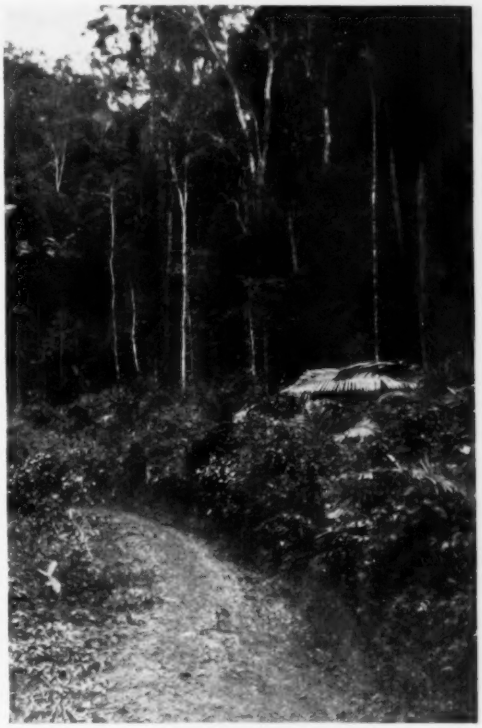

FIGURE 69.—In places the vegetation of the Eastern Coastal Forest is even more dense than that along the Amazon. (Courtesy of the Pan American Union.)

of cretaceous argillaceous schists, giving rise to a heavy clay gray to brown soil. Back of this zone is the tableland of sandstones and clays, in general of low fertility, and farther inland the undulating old crystalline area.

CLIMATE

Lying between 12° and 18° S. latitude and in the face of the constant southeast trade winds, the entire region is hot and humid. In the coastal plain mean monthly temperatures range between 73° and 80° F. While temperatures decrease with elevation in the mountains, since the entire region lies below 3,000 feet, the temperatures are distinctly tropical. The region receives from 50 to 80 inches of rain per year, the precipitation being heaviest to the west

and south of Bahia. Though rainy throughout the year, the area has two periods of heavy precipitation, one in April to July and a second one in October to December. The period April to July witnesses about 50 per cent of the yearly rainfall. No quarter of the year receives less than 10 inches. The high temperatures, heavy rainfall, combined with great humidity are conducive to the growth of a tropical forest.

VEGETATION AND LUMBERING

The region as a whole supports a rainy trade wind forest, but details vary from section to section (Fig. 69). Along the coast are strips, in most places narrow, of scrubby vegetation, with trees poorly developed and the branches burdened with epiphytes; in some places are mangrove forests and in others strips of savanna lands. The main body of the eastern coastal forest begins about 10 to 15 miles inland and extends up the slopes and valleys of the coastal mountains increasing with elevation in number of species and the quality of the trees up to 3,000 feet. The forest is denser, the trees larger, and the variety greater than in the Amazon basin. Tree diameters run from 2 to 3 feet, clear lengths about 50 feet, and total heights more than 300 feet.

While there are 50 or more species of woods which are already of commercial importance, about 30 per cent of the volume of the stands in some localities consists of five kinds of wood—juquitiba (*Courantari spp.*), sapucaya (*Lecythis spp.*), goncalo alves (*Astronium graveolens* and *A. fraxinifolium*), vinhatico (*Enterolobium spp.*), and peroba (*Aspidosperma spp.*).

Along the streams on the coastal slopes and in the mountains many small mills have been constructed and the forest thins out in the face of the saw and ax. On typical stands in Bahia, averaging 8,000 to 10,000 board feet per acre, one per cent of the timber cut has properties and uses similar to rosewood; 10 per cent similar to mahogany; 20 per cent resembles hickory; 40 per cent, birch, maple, beech, and ash; and about 10 per cent Spanish cedar. In addition to supply a local demand for a variety of uses, the forest products are shipped chiefly to cities and towns of the Coffee Region for structural purposes, interior finishing, and furniture. Some of the more valuable woods move to the foreign markets of the northern hemisphere.

AGRICULTURE

For the region as a whole agriculture is little developed. Here and there in the forest clearings and near the small ports corn, beans, cassava, and other products are grown by crude methods in small quantities for local consumption. This is especially true in the mountains of the southern part of the area having a population density of less than four per square mile. To the north and west of the Bay of All Saints, an area having a population density of around 50 per square mile, much of the forest has given way to sugar lands, general farming in a desultory fashion, and to cacao plantations. Crude farming methods, poor machinery and equipment, and much rain at cutting time retard the development of sugar culture in spite of a dark calcareous clay soil of good fertility and fair working qualities. With increased forest clearings, cacao plantations may be established farther south in the deep humid valleys of the Serra do Mar, but coffee does not find here the ex-

ceptionally favorable conditions of soil, temperatures, and rainfall distribution as it does on the São Paulo plateau. Agricultural development in this region will be slow at best owing to the heavy precipitation throughout the year, the sandy marshy coastal plain, heavy timbered mountain slopes, sparse population, and poor transportation facilities.

THE BAHIA CACAO REGION

The Bahia Cacao Region extends for 250 miles in a relatively narrow zone from slightly north of the city of Bahia to the southern part of the state. Even more dependent upon a single crop than the Coffee and General Farming Region, it supplies more than nine-tenths of the Brazilian cacao exports, more than one-third of the national crop of tobacco, and quantities of sugar. It affords exceptionally favorable conditions for the cultivation of its principal products. Despite its prominence as the leading source of cacao in the Americas, the region supports a primitive type of agricultural economy. The scarcity of available labor, arising from the aversion of the natives to working for others, has resulted in a large industry based upon the production of the small-scale cultivator so that the density of population for much of the region attains the rather considerable figure of between 40 and 170 to the square mile. Upon the land which he has cleared of its forest growth, the cultivator and his family, in addition to cacao, produce subsistence crops of corn, beans, cassava, melons, and bananas; wild fruits add to the store of foods. Livestock contribute little to agricultural activity; swine fit best into the common method of production; cattle areas in the higher lands to the west supply beef.

In comparison with the situation in most of Brazil, following the penetration of the coastal forests, transportation problems in the cacao region proper have not hampered materially its major industry; all of the producing zones lie in accessible

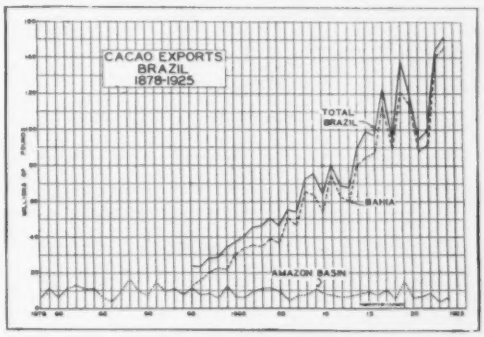

FIGURE 70.—The Cacao Region of Bahia, although under development only since the early 1880's, is at the present time one of the leading areas of production in the world.

positions less than 60 miles from the sea; several small ports, of which Ilheos is the most valuable, handle the exports. Nevertheless, rail connections with a port such as Bahia—a port of call for large vessels—would prove decidedly advantageous. Improved facilities may readily increase productivity, but the labor problem and state and municipal export taxes to the amount of 20 per cent of the export price hinder the industry and are more critical than the present need for railroads.

PHYSICAL CONDITIONS

A primary cause for the localization of agriculture in eastern Bahia lies in the extent of alluvial deposits which in point of area have no rival for several hundred miles south. The numerous rivers descending the interior crystalline plateau have assisted in providing the sands and

clays of these coastal lands and in facilitating intercourse between the sea and the Campos grazing land, a source of labor during the cacao harvest period. Advancing first in the alluvia of the valleys, the cacao industry spread gradually to the lower slopes of the coastal hills to a maximum elevation of some 1,000 feet, onto the well-drained deep soils preferably of siliceous clays affording favorably high contents of phosphoric acid and potash. Tobacco and sugar culture, in the district west of the Bay of All Saints, developed upon the deep and fertile clays characteristic of the hills of the Reconcavo, while coffee is produced on the higher interior lands encircling the bay.

Climatic factors favoring the industries of the region include an annual precipitation of between 60 and more than 80 inches, uniformly distributed seasonally in the south, favoring cacao, and with a distinctly drier period between September and February in the north, excluding cacao and permitting tobacco culture. In addition, the uniformly high temperatures of a humid tropical region prove favorable to the moisture and heat requiring cacao, and the tropical rain forest of much of the area provides shade and protection against winds, requirements quite necessary for the plant.

THE CACAO INDUSTRY

Despite the suitability of the region for cacao production, the industry dates only from the later years of the nineteenth century. Prior to the 1880's, most of the present cacao area consisted of a virgin wilderness. But, with the influx of emancipated slaves from the northeastern sugar districts of the country, interest in the crop increased. As a result, by 1895, exports of cacao from Bahia surpassed those of the Amazon areas (Fig. 70); now one-half million acres grow cacao trees (Fig 71).

FIGURE 71.—The areas producing cacao in Bahia include fertile alluvial tracts on the coastal lowlands and patches of well-drained deep soils in the foothills of the mountains. They extend in separated portions from a few miles north of Rio Jequirica south to Rio Mucury.

As in the case of establishment by the immigrants of the 1880's, production of cacao now consists first of the clearing of small patches of forest and the planting of a few trees in a favored site. Unsystematic and careless in his management of the crop, the native prefers a semi-nomadic life, so that the foundation of extensive plantations requiring a permanent working force involves many difficulties. The only practicable method of attaining large-scale production necessitates the purchase of a number of individual clearings set to cacao and the gradual linking of the various units. In general, the native who has cleared and planted an area is quite willing to sell his little holding and move to another site where in five or six years he has an additional stand of trees

in bearing available for purchase. Where plantations have become possible by reason of willingness of natives to remain on the land, careful methods of production prevail.

For the region as a whole, methodical tillage of cacao groves is uncommon, but from time to time the growth of weeds is removed with hoes. The necessity for shading the delicate leaves favors at least one element of proper cultivation and in some cases also provides a windbreak. In addition to protecting the plants, the shade growths obtained either by allowing a few trees of the original growth to remain or by planting banana or plantain and similar plants for temporary shade, benefit soils in preventing undue evaporation and rapid decomposition of humus under the tropical sun. Furthermore, foliage furnishes valuable humus, and should a legume be employed the soil obtains a supply of nitrogen. Negligence in culture, notably evident, results in a considerable portion of the native crop reaching shipping houses affected by diseases and insect pests; various rodents also ravage the crops.

Throughout the primary stage in the production of cacao natural advantages enable the Bahia regions to excel other major cacao areas of the world, but between preparation of harvest and final marketing of the raw product, inadequate facilities and crude methods hinder the industry; furthermore, artificial restrictions of state and federal taxes total some 20 per cent of the export price. These handicaps limit materially the ability of the region to compete with such favored areas as those of the Gold Coast where in addition to a superior agricultural economy, governmental encouragement obtains.

OTHER CROPS

Less hampered by dependence upon foreign markets, the tobacco lands, though poorly managed, profit by proximity to the leading port of the State of Bahia. The principal producing districts, totalling approximately 75,000 acres, lie to the northeast of the mouth of the Paraguassu. Bahia tobacco occupies a favored position in European markets as well as in domestic trade so that production increases constantly.

TRENDS

Under the influences of the expanding world consumption of cacao and the fact that plantations once in bearing continue to yield profitably for many years, the trend towards over-emphasis of the principal cash crops of the region may precipitate an aggravated crisis should ever-lurking disease or insect pest flare into dangerous prominence. Yet, much opportunity exists for improvement of production, transportation means, and marketing; the development of these together with a possible revoking of exorbitant tariffs may initiate an era of great progress in the cacao industry. Tobacco also, second crop of the region, to a far greater extent than coffee or sugar, has a secure basis for extension of culture in the heavy consumption of the product within Brazil, in other South American countries, and in European markets. For the region as a whole, the dangers attendant upon continued exploitation of one or two principal crops possess relatively little significance in the present stage of development because the agricultural population evinces disinclination towards prolonged residence in one area, and it produces food crops

in small clearings in quantities sufficient to supply local needs.

COTTON-SUGAR REGION OF NORTHEASTERN BRAZIL

In early days the production of tropical crops raised these lands of northeastern Brazil to preëminence among the agricultural areas of South America. Suitability of regional conditions for soil cultivation, maintenance of a plantation system based on slaves, and proximity to Europe furthered the advance of sugar and cotton in Sergipe, Alagoas, Pernambuco, Parahyba, and Rio Grande do Norte. So influential a position did the two great crops of colonial days possess that down to the present the Cotton-Sugar Region has been among the most densely peopled areas in South America; the principal city, Pernambuco, with a population of 360,000, ranks fourth among the urban centers of Brazil. The five component states have almost one-fifth of the population of the country but less than one-twentieth of its area. Over a large district adjacent to Recife, more than 170 persons live on each square mile. Neither the rich Campos district of Rio de Janeiro nor the heart of the São Paulo plateau supports a concentration of population so striking. In accordance with the importance of its agricultural districts the region possesses a net of rail lines, focussing upon Recife, collecting and distributing center for the productive hinterland.

PHYSICAL CHARACTER

The bases for the primary growth of population account amply for the present position of the region. Here no great forest-clad mountain wall bared the way for man. The luxuriant growth that did exist lay a short distance from the coast, on accessible and fertile soils. Moreover, the climate so distinctly excelled that of the lands of Maranhão and Ceará that the Portuguese quickly recognized the value of establishing an important agricultural colony. The fact that Recife lies nearer Europe than any other large port of South America supplied an additional attraction.

TOPOGRAPHY AND SOILS

The moderate relief of the coastal lands has served to expedite agricultural development. Inland from the groves of coconut palms, studding the dunes near the strand, stretches a low coastal plain, the sandy soils of which produce much cane. To the west this gives way to the sugar zone *par excellence*—the *matta*. With young red soils, deep and fertile, derived from the crystalline rocks of the interior plateau under protection of a forest cover, the *matta* favors cultivation of cane to a marked extent. The plantations cover alluvial deposits in the valleys and attain the lower slopes of the rolling hills. At its inner margin which lies at 30 to 50 miles from the coast, the *matta* is succeeded by the higher drier territory of the *agreste*, a land devoted in the main to pastoral industries. The cotton fields occupy parts of both *matta* and *agreste*.

CLIMATE

As the northernmost extension of the rainy coastal strip of eastern Brazil, much of the Cotton-Sugar Region enjoys the benefits of rainfall favorable in quantity as well as distribution and of elevated temperatures highly propitiative to plant growth. The régime of rains differs markedly from that of its neighbor, the Semi-

Arid Grazing and Crops Region; the higher lands, the *agreste*, devoted largely to cotton, partake somewhat of the character peculiar to the interior. These western areas receive between 30 and 40 inches of rain annually, the maximum occurring in the period December to March inclusive. As in the *sertão* of the adjacent region, prolonged drought may emphasize the dry season ushered in during the interval about the autumnal equinox. On the other hand, the *matta* in general has an annual quota of some 40 to more than 60 inches of rain which falls principally between March and August. The dry season, though distinct, involves no great aridity. Sugar cane culture near the coast denotes the adequacy of *matta* rains, cotton in the interior the hot arid periods of the uplands. So sharp is the distinction between the two zones, that laborers who gather cotton in the *sertão* in the months beginning with July—following the rainy season—are free to undertake the major harvest of the *matta* which begins some three months later—at the end of the rains of the latter district.

FIGURE 72.—Nearly one-half of cotton acreage of Brazil lies in the Cotton-Sugar Region of the northeastern part of the country.

AGRICULTURAL PRODUCTS

The dependence of this region upon sugar and cotton has continued for so long a period that certain elements of a balanced economy have failed to appear. For some time, nevertheless, no dangerous situation can arise, for the products find a large domestic market. If the region were dependent upon foreign commerce its agriculture long since would have undergone profound modifications.

Here live some seven million people, with relatively low purchasing power. Yet, more than half of the 1,250,000 acres of cultivated land is devoted to two industrial crops. Cotton, the less directly utilizable of the two, occupies alone some 35 per cent of the total. Owing to the long established trade with the *sertão*, the apparent paucity of a subsistence agriculture loses part of its import, for thousands of cattle are driven to the *matta* zone each year. Moreover, the productivity of corn, cassava, and beans diminishes the perils of overspecialization in cotton and sugar. In addition, the tropical luxuriance permits production of a number of lesser crops, such as tobacco, coconuts, castor beans, and cacao. Swine and sheep supplement the beef diet.

COTTON

Among the first crops to become important in Brazil, cotton has played a part in the agriculture of the Cotton-Sugar Region since the early colonial days. Produced largely in Pernambuco and Parahyba, it is the principal export of the area and promises to continue so because of its excellence and the expanding Brazilian markets (Fig. 72).

Owing to the differences in physical conditions, the region grows two distinct types of cotton—*matta* and *sertão*. The first class, producing a short course fiber of great strength, characterizes the eastern lands of heavier rainfall. Ordinarily an annual, the plant may yield one ratoon crop. *Sertão* cotton is superior to that of the *matta* in most respects, but in point of annual yield the latter excels. A perennial tree variety, the upland type produces a long and strong silky fiber. On occasion it remains in the field for as much as five years.

Cultural methods remain primitive. In the manner which has prevailed for centuries, the crop is produced chiefly on small farms. With little effort to break the ground, the cultivator starts his fields by planting seed among the débris remaining after the forest growth has been burned. Commonly, he grows crops of corn, beans, or cassava, among the cotton plants. However large and abundant, weeds are ignored. This general indifference to careful means of production is evident in the final baled product as well. The constant progress of the southern cotton areas in São Paulo points to a continued withdrawal of markets for the north, unless labor conditions and methods of culture improve. On the other hand, an immediate market of seven million people suggests a prosperous future for the cotton mills of Recife, which in turn indicate the likelihood of refinement in raw materials.

SUGAR

Though it takes but five-eighths as much land as cotton, sugar contributes far more to the sustenance of the inhabitants, directly or indirectly (Fig. 73). This crop, too, has had a long history in the region. The colonial settlers quickly grasped the opportunities for production of cane for export. In time, this interest led to the peopling of the lands about Recife by the element now preponderating—the negro—descendant of the numerous slaves laboring on the plantations of the nineteenth century.

The fertility of the soils in the lowlands extending across the *matta* promoted the rapid growth of cane acreage, principally in the southern states. In Parahyba and Rio Grande do Norte the length of the dry season and the generally smaller annual rainfall result in a notable unimportance of cane cultivation. On the whole cultural methods resemble those in vogue for cotton. Each sugar mill draws upon a number of small cane fields tended by share farmers. Modernization of cultivation proves next to impossible. Life is too easy for the cultivator. The factories as well lack efficient equipment, although their numbers and size enable the Cotton-Sugar Region to manufacture more than half the sugar produced in Brazil. As distinguished from cotton, virtually none of the sugar goes to foreign markets. Other regions of Brazil purchase large quantities and within the area the sweet supplements the diet of vegetables and grain to a considerable degree.

THE PROSPECT

The major crops of the present day have dominated agricultural economy in the Cotton-Sugar Region since early settlement. Physical conditions are so suited to the requirements of both products, cotton in the drier west and north, sugar in the moister zone tributary to the coast,

that population has evinced little interest or aptitude for other cash crops. The size of easily reached markets contributes to both regional and extra-regional advantages. Hence, notwithstanding possibly adverse eventualities, cotton and sugar will retain premier rank among the crops.

Developments in the Coffee and General Farming Region in particular conflict with the potential prosperity of the northeast. Both cotton and sugar find a favorable place in the southern region. Proximity to the bulk of Brazilian population and a better developed rail service augment the superiorities of the plateau lands in São Paulo and Minas Geraes. Paucity of rolling stock in the vicinity of Pernambuco has frequently hampered the marketing of produce.

The machinery of improvement accompanying investment of foreign capital and succeeding the experience gained in competitive marketing already gathers momentum. Grading of cotton and careful handling of sugar have started. A permanent retention of present significance, however, entails considerably more perfection of technique than now in immediate prospect. Nevertheless, the ordinary rural inhabitant has little to fear. His needs are few, his ambition limited, his fields productive. It is rather to the influence of Recife that cotton and sugar will owe whatever development may come.

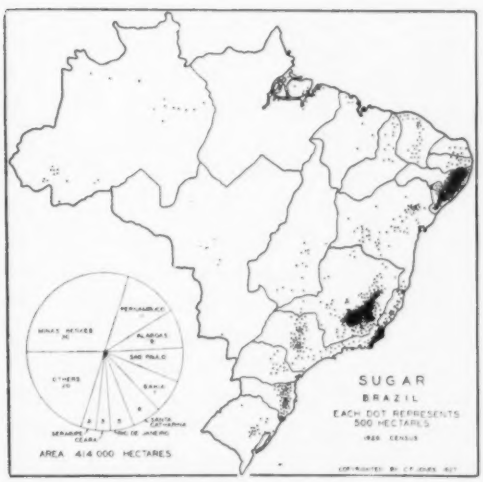

FIGURE 73.—Sugar is grown in every state of Brazil. There are three marked regions of concentration, the Plateau of Minas Geraes, Campos of northern Rio de Janeiro, and the sugar lands of northeastern Brazil.

SEMI-ARID GRAZING AND CROPS REGION OF NORTHEASTERN BRAZIL

The preciseness of adjustment of economic activities to an area embracing so great a diversity of physical conditions as that of the lands included in the Semi-Arid Grazing and Crops Region of Northeastern Brazil had led to a most complex expression of agricultural economy. Nevertheless, the several portions of the region maintain an interdependence sufficiently notable to justify their treatment as a unit.

Over an extent roughly equivalent to that of the Paraná-Uruguay Grazing Region, sea, mountain, and interior basin combine a physical and economic physiognomy in striking contrast to the uniformity in the lands of the Paraná basin. Here the physical landscape comprises three major divisions: northern lowlands of limited area with relative abundance of rainfall; *sertão*, parched uplands of brushwood and grasses interspersed with patches of hard-leaved *caatinga; serra*, elevated mountain zones, islands of comparatively luxuriant tropical vegetation and supporting the most advanced agricultural districts. Correspondingly, utilization of resources ranges from production, in many areas by irrigation, of sugar,

cassava, and cotton, to the use of native vegetation for grazing by cattle of inferior type and foraging by most of the goats in Brazil. Everywhere drought is a menace, the likelihood of which causes constant preoccupation for the inhabitant. Life is precarious. Indeed, owing to the high density of population, the region, particularly in the *sertão*, constitutes one of the important famine zones of the world. Emigrations following recurrent prolonged droughts have reached considerable proportions.

Notwithstanding its uninviting character, the region from early days has supported a relatively large population; each colonial settlement on the coast possessed its tributary zone of livestock production to supplement the chief interests in sugar cane, tobacco, and cotton. Ceará, half as large as the more temperate state of Paraná, at present supports a population twice that of the southern area. With the growth of population in Brazil, this apparent anomaly becomes less pronounced, but it indicates the early regard for the tropical lands of the country which led to the virtual overpeopling of the region. Lack of communications hampers the growth of the region; railroads are few and rivers in general unnavigable.

In addition to the geographic individuality of the region provided by terrane and products, the composition of population adds to the factors permitting the outlining of a land of Semi-arid Grazing and Crops in northeastern Brazil. In contrast to the bordering eastern coastal regions, here the negro slave contributed little to the population. The half-breeds predominate—descendants of early Portuguese colonist and indigenous Indian.

PHYSICAL CHARACTER

In the light of difficulties encountered by the early settler in penetrating the heavy forests of other areas of Brazil, forests especially formidable in the coastal margins of the south because of their growth upon the flanks of the Serra do Mar, the low, flat coasts of Ceará, Rio Grande do Norte, and neighboring states bearing only a meagre stand of scrubby trees and grasses readily lent themselves to settlement. At the same time the plateau character of the peneplain of northeast Brazil facilitated advance into the hinterland. In comparison with the plateau lands of São Paulo the resources available in the interior failed to maintain the standard of regional suitability for human development. Scantiness and irregularity of water supply constitute the most conspicuous natural defects, for the soils of the rolling lands prove fertile over large tracts, and during the rainy season grasses grow rapidly.

CLIMATE

Much of the region receives an annual rainfall greater than that for most of the Pampa; a maximum rainfall of sixty inches annually occurs on the coast in the vicinity of Fortaleza, and in isolated mountain zones of the *Serras*. In contrast less than thirty inches fall in the area to the immediate north of the great bend of the São Francisco River. However, high temperatures arising from low latitude and disposition of topography greatly minimize the effectiveness of the precipitation. In addition, precipitation is irregular and uncertain. Areas in the state of Ceará which may receive more than twenty inches of rain in one season (March, April,

May), in a corresponding period a few months later (September, October, November) suffer from marked aridity with less than two inches. In the southern part of the region June, July, and August signify drought months also; moreover, the precipitation of the short wet season comes in heavy rains of limited extent.

The coming of the rains gives the parched country an entirely new aspect. Relatively rich soils and elevated temperatures stimulate rapid growth. Herds become fat and sleek. The region prospers. On the other hand, should the anxiously awaited rainy season, which begins ordinarily in January, fail to materialize, the land faces the prospect of a wretched year. Then, the same temperatures and the intensity of evaporation, favored also by the southeasterly trades at the summer season, wither all life. Vegetation adopts all of the xerophytic adaptations at its command; livestock, less favored, seeks water and finding none in many years perishes; then man engages in a veritable exodus to other lands.

Such migrations from the *sertão* have peopled other districts of Brazil, especially the Amazon basin, and have reached huge proportions. Of the long series of memorable droughts between 1792 and 1914–1915,[2] that of 1877–1879 cost the region practically all of its livestock, and in the year 1878 alone 54,000 inhabitants left Ceará. Estimates of even normal annual emigration for the region reach 15,000 to 20,000. The only practicable remedy directed at diminishing the effects of drought lies in the extension of irrigation works, but the region is large, communications difficult, and money lacking.

[2] Memorable droughts occurred in the following years: 1792, 1808–1809, 1816–1817, 1824–1825, 1844–1845, 1877–1879, 1888–1889, 1902–1903, and 1914–1915.

TOPOGRAPHY

Rising to a maximum elevation of somewhat over 3,000 feet in the east the plateau of northeast Brazil for the greater part has the characteristic peneplain landscape, though prominent interruptions exist, indicated generally by a distinct form of agricultural activity. In various higher districts, horizontal layers of sandstones and limestones underlie the surface, the porosity of which accentuates the aridity of the land. The region has undergone heavy denudation, as a consequence of the scant cover of vegetation and the torrential character of the rains, so that in rather extensive tracts outcropping bedrock diminishes the utility of the land.

The granitic *serras* in isolated monadnock peaks or in extended massifs constitute veritable oases when their height proves sufficient to give them greater rainfall. The two principal ranges, Serra de Baturite and Serra do Sobral, both situated near the coast, seem regions of limitless wealth in comparison with the encompassing barren *sertão*. Here sufficient water is obtained to raise, in cases without irrigation, frequent crops of coffee on the slopes and sugar in the valley bottoms. Naturally, the heights soon became overpopulated, their forests destroyed, and their soils exhausted and badly eroded.

The rivers of the region contribute to the difficulties of maintaining steady agricultural production, aside from their lack of navigability. While their courses across the resistant ridges and at the margins of the crystalline area provide narrow gorges adapted to the construction of

dams, blocking of the streams to secure more reliable supplies of water involves flooding of the agricultural lands concentrated in the valleys.

VEGETATION

The major industries of the region depend either upon the areas of *caatinga* vegetation or upon the few forested zones. Covering the vast extent of the interior, *sertão*, the *caatinga*, provides the basis for the rearing of livestock. A dense brush, which varies considerably in aspect from season to season, becomes sere and desolate in appearance during the dry season, while at the time of the rains it acquires foliage and quickly takes the form of a green forest. The *caatinga* includes especially numerous *mimosae*, the trees generally stunted and thorny, several *bombaceae*, the rubber producing *manicobá*, (*manihot glaziouri*) and various cacti. Arborescent forms may disappear, particularly in the barren granites of the Borborema Plateau at the east of the region in Parahyba, Rio Grande do Norte, and in the more arid lands of the São Francisco trough. In such places cacti predominate. During the season of rains, various herbaceous growths spring up under the trees. In the moister alluvial plains of the coastal streams, principally that of the Jaguaribe River, the valuable carnaúba palm occurs. The most luxuriant expression of natural vegetation belongs to certain of the *serra* heights, where orchid, palm, and other forms of the evergreen tropical rain forest abound. Such areas at present comprise only tiny fragments of the original cover; their wealth was too great to permit perpetuation. Although, following clearing, the tramping by the herds hinders natural reforestation, considerable tracts have produced a new growth in which large arborescent forms yet predominate.

PRODUCTS AND INDUSTRIES

Despite the meagreness of some years, the region continues to produce a number of agricultural commodities, both for export and to supply its own comparatively large population. Owing to the several differences in physical character, the economy of the *sertão* offers a pronounced contrast to that pertaining to the *serra*. In the former, as a whole, preëminently the land of the grazier, crops with the exception of cotton become significant only in supplying the laborers for the individual cattle *fazenda* and the fields are protected against the animals; locally, however, moist lands become preponderantly crop areas. Cattle and goats occupy the time of the inhabitant of the *sertão*. On the other hand in the *serra*, crops find a favorable opportunity for prominence. Here the few animals are kept from the fields of cotton, sugar, tobacco, coffee, and less important cash products, by corrals or by tethering. In all parts of the region, cassava, corn, and beans complement the meat and milk diet of the population. A third class of products, those obtained essentially from the native vegetation, comprising the carnaúba and rubber yielding forms, belongs properly to the activities of the *sertão*.

The contrast in terrane and products between *sertão* and *serra* becomes especially prominent during periods of drought, for with the first premonitions of a poor year, movement from the grazing lands towards the mountains commences. This leads to overpeopling of the *serra*, but inas-

FIGURE 74.—The close accordance of semi-arid lands and grazing of goats establishes one of the distinctive geographic aspects of northeastern Brazil.

much as transportation facilities can hardly cope with the problems of carrying foodstuffs to all districts, it represents the only possible means of self-preservation for the inhabitant of the *sertão*.

AGRICULTURE IN THE SERTÃO

A scrubby lot, the three million cattle of the *sertão*, form the basis for the principal industry. Hardy animals in which the zebu strain is prominent, they graze over the meagre growths of the *caatinga*, a difficult mode of production, but one which has continued for several centuries. The cattle estates embrace vast areas, each an independent unit also producing so far as possible its food crops. The cultivation of crops, is undertaken rarely by the characteristic cowhand or *vaqueiro*, a regionally peculiar nomadic type, principally of Indian blood. Rather small colonies of permanent settlers devote their efforts during the rainy season to the production of crops for the ranch.

Methods of utilization of the animals differ quite prominently from those in vogue in southern Brazil or in Argentina. Reaching marketable age at four years, the cattle are sold at the numerous fairs held throughout the year in various districts of the *sertão*. In general, few cattle remain in the *sertão* for use by the producers. Not only is the population sparse in the grazing areas proper, but with respect to animal products it prefers a dairy diet and prepares quantities of milk and cheese for local consumption. Approximately one-third of the animals reach the abattoirs of Fortaleza (population 80,000), an equal portion supplies the densely populated lands of the *serras*, and the remainder travel on foot to the coast to embark for Pará; hides furnish a leading export of the region.

The wide variations in numbers of cattle from year to year indicate the major problem of the livestock industry, water supply. The construction of more than 40 reservoirs has mitigated the effects of drought in certain areas, but the region, as a whole, lacks adequate water in the dry season. With the close of the rainy season and the gradual exhaustion of surface waters, the work of the *vaqueiro* becomes more difficult. Then digging of wells in every likely spot begins. At the same time, exhaustion of the growth of grasses necessitates rations of fodder, provided generally by the leaves of the *mimosas*, the leaves of which precede the rains, and by cacti stripped of spines.

Goats, adapted to these semi-arid lands far more than cattle, graze over most of the region (Fig. 74). With numbers totalling some three million animals, the goat industry of the region is a major source of goatskins in international trade.

While grazing dominates agricultural life in the *sertão* proper, in the aggregate crop cultivation plays a considerable part in supporting the region. There are two classes of producing lands. In one, the *roçado*, clearings in the brush encircled by a protective fence, are planted to various crops immediately after the first rains. Low moist lands, *vasantes*, compose a second group. Crops may not be realized every year. Drought ruins the prospects of the *roçado* especially, and should heavy rains occur, flood may destroy the crop of the *vasantes* for these often occupy the river flood-plains.

Grains, cassava, and cotton are the principal crops. Cotton has had a varied evolution in the region and is the only crop regularly exported from these lands. At the time of the Civil War in the United States, as was the case in other parts of South America, cotton sprang into importance. Whenever the rains were sufficient the crop throve, securing especial benefit from the pronounced dry season. Recovery of the American industry and the growth of new areas in Brazil reduced the prosperity of that in the *sertão*; but the crop persists to the extent of almost 100,000 acres, produced largely in the state of Ceará which ranks fourth among the states of Brazil in acreage of cotton. Independent production on a small scale by those who cultivate crops for the cattle estates commonly prevails. Tree-cotton of high quality is the usual type. With the growing assurance of irrigating waters provided by numerous dams under construction, the crop will become increasingly important in the region. Among the richest zones of the *sertão* is the *Seridó*, situated on the western slopes of the plateau of Borborema, where several hundred small diversion dams enable the transformation of one of the driest sections of the region into a district producing an abundance of crops.

Of the few native plant industries, that of the carnaúba palm possesses first importance. Drought-resistant and relatively numerous in the coastal areas, the tree yields a number of products, edible as well as inedible, the most valuable of which—a wax—is exported in considerable quantities. Shortage and inefficiency of labor hinder expansion in the industry. Unimportant exploitations of two rubber-producing plants has added in a small way to the list of exports.

THE SERRA

The *Serra* zones, limited in area, manifest the characters peculiar to desert oases. They are havens of refuge in time of drought and producers of important cultivated crops for the entire area. Cultivation of land dominates. Moreover, as agriculturists primarily, the life of the inhabitants differs broadly from that of the breeders of livestock. On the whole the peoples of the *serra* send little directly to those of the *sertão*. Instead the population of the grazing land goes to the mountains for the commodities required, chiefly sugar, alcohol, and coffee. Little commerce in primary plant foodstuffs exists, each zone sufficient during normal years to itself in grains, cassava, and beans.

Among the numerous crops obtained as a consequence of the favorable physical condition, cotton holds first rank as a cash crop. Several factors, however, hamper extension of its cultivation: lack of labor and capital, negligent methods of production and marketing, and the ravages

of the boll weevil, in addition to the constant possibility of prolonged drought.

Sugar affords the *serra* the product with which it effects closest relations with the *sertão*. Practically none is exported, but in the form of concentrates syrup, rum, or alcohol, the crop goes to all parts of the region. Prior to the notable drought of 1877–1879, it was the basis of an era of great prosperity in Ceará. Paucity of slave labor in comparison with the situation in other parts of Brazil contributed to the eventual decadence of the industry. The drought hastened the decline. Nevertheless, its importance in the diet of the region gives the crop an areal extent of some 60,000 acres, with a major concentration in southern Ceará, where the springs of the Chapada do Araripe make possible its cultivation.

Coffee is the second crop of the *serra* destined to leave the mountain slopes for distribution among the inhabitants of the *sertão*. Though but 30,000 acres are devoted to the crop, principally in the Serra de Baturité, it is important. To the native, coffee constitutes as vital a necessity as yerba maté to the peoples of the Paraná basin. The trees occupy the slopes above the cane. As with all crops, its production from year to year varies greatly.

REGIONAL POSSIBILITIES

For a more thorough utilization of resources, several factors influencing agriculture in the region require modification, so that the perils of drought may be minimized. The Brazilian government has undertaken an extensive program of irrigation and inculcation of dry-farming methods, but the region covers a vast expanse. Expansion of railroads and motor roads can further production in the region likewise, both in effecting better facilities for exchange between *sertão* and *serra* and in permitting rapid land communication with the rich coastal lands of the Cotton-Sugar Region.

Widespread improvement of agricultural conditions remains an accomplishment of the distant future. The region produces few commodities enriching the country as a whole. Despite its population and relative proximity to centers such as Bahia and Recife, it suffers from isolation; it holds little lure for the European immigrant. Moreover, the far more productive lands of southeastern Brazil have a better claim upon funds destined to the development of natural resources. For many years, the region will continue to exhibit the major features of the economy of land now prevailing. *Sertão* and *serra* will continue in mutual dependence and to a great degree in combined self-sufficiency during favorable periods.

CAMPOS GRAZING REGION

The Campos Grazing Region embraces the vast expanse of the interior Brazilian plateau and the adjacent plains in Paraguay and Bolivia. In spite of large areas it shows a striking homogeneity in agricultural utilization. The influence of climatic conditions upon the vegetation of this subtropical region has provided, in large part, the basis for this unity of economic response; these lands represent the largest relatively unutilized though fairly promising grazing territory of the world.

Like practically all other sections of Brazil inadequacy of transportation facilities retards development.

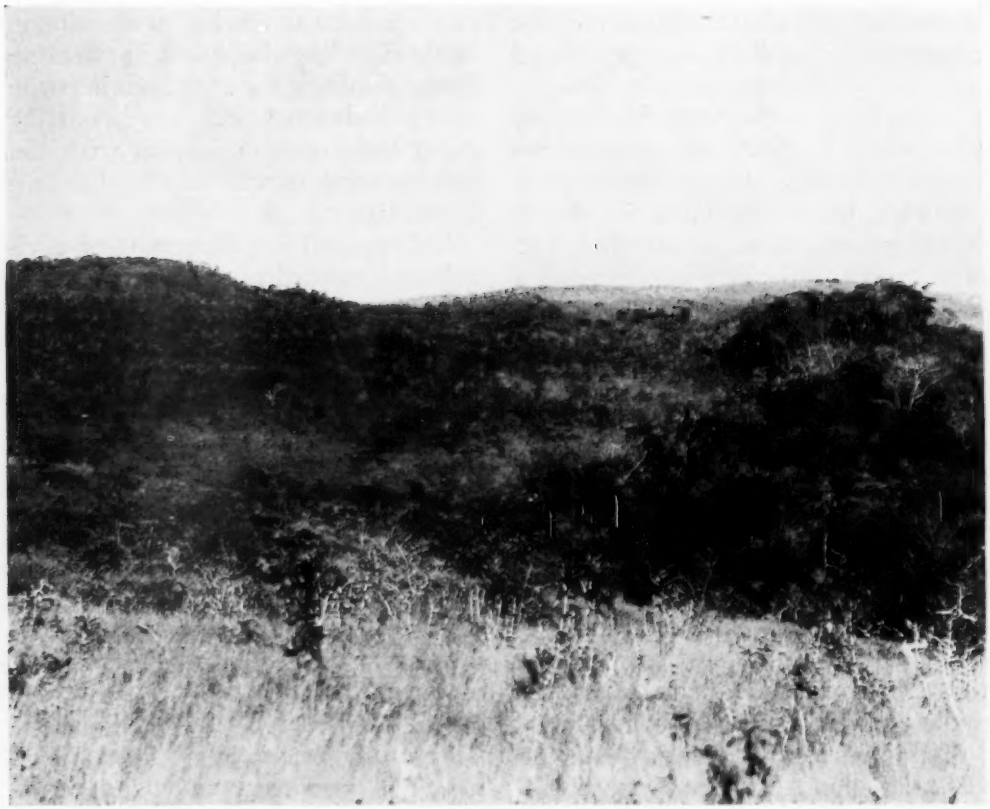

FIGURE 75.—Typical Campos grass and *cerrado* growth between Tavares and Bella Vista, Goyaz. (Courtesy of Ernest G. Holt.)

The principal grazing areas lie at considerable distances from the sea; owing to the hugeness of the region the grazing areas can scarcely justify extension of suitable rail services in the light of needs arising in more productive districts. Though a major outlet utilizes the Paraguay River, fluvial carriage can do little to aid further progress. From Corumbá, the principal shipping point of the central Campos, the journey downstream is slow, tedious, and a long one for cattle. Buenos Aires lies 1,422 miles distant.

Sparse population reflects further both isolation and the leading industry. Gained only with hardship the interior averages less than one inhabitant per square mile. Indigenous Indian groups compose most of the population. Much of the Amazon Basin supports far more people per unit of area. A few men can guide large herds, and the comparatively unimportant forest enterprises are carried on in sporadic fashion. Hence communities attain only diminutive proportions. Corumbá, serving a hinterland larger than the Pampa, contains less than 20,000 people.

CLIMATE

Despite a latitudinal extent of more than twenty degrees, the distinct dry season of winter from which the region obtains a primary basis for definition, characterizes the area as a whole. Were it not for the

drought of June, July, and August, tropical rain forest rather than Campos might clothe the far-flung plateaus except for parts of the São Francisco Valley. As contrasted with the exceptional lack of precipitation during the winter, summer brings singularly heavy rains. Cuyabá, located in the basin of the upper Paraguay, registers nine-tenths of an inch of rain in the quarter, June–July–August, and 28.4 inches in the period, December–January–February. Much of the latter falls in violent thunderstorms. This unequal distribution of heavy rainfall through the year is conducive to the growth of a tropical savanna.

Somewhat variable temperatures over much of the land favor human occupancy, particularly in the higher east. Diurnal variations may exceed 40 degrees. Especially in winter, when the reduced relative humidity permits intense nocturnal radiation the minima may touch unusually low levels. At the same time, however, the low latitudes and in cases the low elevation occasion further high day temperatures, maxima attaining 105 degrees.

TOPOGRAPHY

Though the plateau may serve to illustrate agriculture in the region as a whole, various differences exist in topographic physiognomy and in consequent human response. In its reach from Andean foothills to Serra do Mar near the sea, the Campos Grazing Region embraces several physiographic provinces.

On the west, from the margins of the Paraguay River far into eastern Bolivia, extend the low flat alluvial lands of interior South America. Frequently marshy, these lands support a large part of the cattle of the region, principally in the districts bordering the streams. Here grazing has found an advantage over that on the plateau because of its proximity to the great river highway. Eastward the great plateaus of Matto Grosso and Goyaz dominate the region.

In the main, the uplands of Matto Grosso, averaging an elevation of some 1,600 to 2,500 feet, consist of broad flat-topped areas rising above the less uniform districts which characterize also the lands to the east. These level expanses known as *chapadas* are potential cattle lands of considerable importance. Produced by sandstones they possess soils inferior to those found on the crystalline areas, such as the peneplain of south Goyaz.

In addition to alluvia and the *chapadas* which lie over one-third or more of the region, there are the crystalline peneplains of the east, in Goyaz and in the basin of the São Francisco River. These are the richest lands of the Campos Grazing Region, tillage of the deep red soils already forming an important part of human economy in the vicinity of Goyaz City. Separating the two portions of this province, the heavily forested Serra do Paranán, reaching a maximum elevation of 5,000 feet, constitutes a part of the *chapadas*.

VEGETATION

The vast expanse of *campos* vegetation which gives character to the region as a whole covers some two-thirds of the area. Forests, however, are an important element of the natural vegetation in river valleys where moisture may be obtained and on elevated districts where more uniform distribution of rains prevails.

The *campos* in general comprise a

savanna formation over which rather widely scattered stunted arborescent forms rise above a cover of grasses, herbaceous plants, and shrubs. Between rainy season and dry season a notable alteration of aspect occurs. With the cessation of rains the whole savanna becomes a parched and desolate realm. Grasses lose succulence quickly and become harsh and unpalatable. The natives resort to annual fires to obtain a growth of nutritious grasses. This is an important hindrance to the pastoral industry owing to the impracticability of providing prepared fodder. The onset of the rains transforms the land into a flowery luxuriance of green vegetation.

FIGURE 76.—Lagoa Santa, Minas Geraes. Farmsteads and fenced pasture lands on the border zone between the Campos and Coffee Regions. (Courtesy of Ernest G. Holt.)

Two types of *campo* characterize the region: *campo cerrado* and *campo limpo*. The former endows the sandstone as well as the crystalline plateaus with a savanna of hard scanty growth of grasses interspersed with various trees some of which have economic value (Fig. 75). In contrast, the *campo limpo* occurring in physically droughty soils supports no tree growth. It covers a relatively small area.

In all parts of the region, gallery forests mark the stream courses, and in certain sections such as portions of Minas Geraes, conditions of underground water permit an extensive stand of trees. Towards northwest and southeast, differences in rains permit the natural vegetation to assume gradually the aspect of Amazonian forests and of those of southeastern Brazil respectively. In the northeast, the *campo cerrado* gives way to characteristic growths of the more zerophytic *caatinga* peculiar to most of the Semi-Arid Grazing and Crops Region of Northeastern Brazil and to much of the São Francisco districts. Gathering of rubber yielded by species of Hevea and Castilloa, as well as the *mangabeira* and collecting of the root of the *ipecauanha* are the principal forest industries.

The great marshes of the upper Paraguay and in eastern Bolivia

constitute an additional element in the vegetal complex. Those of the former, especially, are favorable to the pastoral industry, as shown in the concentration of cattle about Corumbá and Cuyabá.

THE CAMPOS GRAZING INDUSTRY

Over these great interior grasslands, cattle grazing is perforce the major occupation. Although the industry suffers under the weight of a multitude of handicaps, the few natural advantages combined with the effects of various hindrances indicate its long-continued dominance as a human activity in the region.

The millions of cattle grazing the lands are grouped in many parts of the region, but much territory remains untouched and a considerable portion can support not even a rudimentary utilization of its resources (Fig. 76). The principal districts lie about the plains adjacent to the Paraguay River, in the more healthful uplands of southern Gayaz, and in the savannas of eastern Bolivia.

The industry of the Paraguay district, which now numbers some five million cattle obtained an early start. In response to the needs of the gold and diamond mining enterprises early dominating exploitations of the district, the *fazendas* gathered first upon the higher lands about the alluvial plains. The attractiveness of the water meadows, however, despite flood dangers, drew the herds to the river. While care of herds proves difficult, owing to nature of terrane and problems of raising horses in the humid areas, location near the river means access to transportation facilities.

Goyaz and Minas Geraes, which also produced cattle for the miners, though now grazing fewer animals than the western district, promise considerable development. The climate favors both man and animals to a greater extent than farther in the interior and rail connections of some utility contribute an additional advantage.

Herds are large and of poor quality. Wide of horn, bony of frame, and difficult to fatten, the cattle serve only to produce hides and jerked beef. Various attempts to improve the general type, principally by the introduction of zebu cattle, have affected little wholsesale raising of standards as yet. The difficulties of production in comparison with such favored areas as southern and east-central Brazil, not to mention the Pampa, prevent naturally the investment of much capital in the importation of purebred stock. Open range grazing increases immensely the problems of careful breeding. Moreover, the native population, illiterate and nomadic, displays little interest in the possibilities of obtaining better herds.

On the whole, grazing in the Campos Region is of importance rather as a potential resource when pressure of crops or pasture lands becomes sufficiently great in other parts of the world. At present physical and economic disadvantages preponderate to so great a degree that little can be accomplished for scores of years. Though the capacious savannas in part possess fairly nutritious grasses and normally dependable water supplies, over large areas they contend with a long list of detrimental factors. Isolation is a major deterrent; the grasses are harsh and necessitate frequent burnings; tick, plus hoof-and-mouth disease, take enormous toll in quality and numbers; drought exercises a similar in-

fluence. Such features long will keep the herds of the Campos in a mediocre state of development.

TILLAGE OF LAND

In many respects displaying prospects of a future more rosy than grazing, the production of crops acquires increased significance in the east. Rich soils and favorable climate in southern Goyaz and western Minas Geraes which long supplied miners with tobacco, sugar, and other provisions foster a growing use of the land. These uplands produce quantities of rice, beans, and sugar, and export much excellent tobacco. Also, coffee and cotton are of some importance. In all, the cultivated area includes some 300,000 acres. Sparsity of population and isolation are limiting factors, but as is the case with grazing, potential crop production in this region provides an important additional resource for Brazil.

THE FUTURE

Inferior in so many respects to the productive capacities of better situated lands, the Campos Grazing Region in its entirety can undergo little material progress in the near future. The many handicaps of conditions harmful to the grazing industry plus that of isolation which affects all portions are too powerful to permit present-day utilization of resources to any marked extent. A large part of the continent of South America will experience tremendous growth before these broad savanna lands advance much in agricultural development.

THE POTASH INDUSTRY OF EUROPE

Fred S. Mohme
Geologist, University of Illinois

THE discovery of immense deposits of salts in Germany nearly seventy years ago afforded the first opportunity to secure potash at a low cost. This resulted in its widespread use in agriculture, so that today it is regarded as an essential ingredient of mixed fertilizer. But further, an adequate and unrestricted supply of this mineral has become indispensable in order to effectively produce the food requirements of a continuously growing population.

Sources of Potash

Potash has been obtained from various sources, such as sea water, brines, and salt lake deposits; from vegetable substances (wood ashes, seaweeds, and beet sugar residues); from animal material (wool washings); from blast furnaces and cement plants; from insoluble minerals (alunite, feldspar, and leucite); but the solid deposits of soluble potash minerals, such as carnallite, sylvinite, and kainite are by far the most important. In fact, nearly the entire world's supply of potash is now obtained from that source, for in 1925 the German and French mines alone furnished more than 95 per cent.

Considerable confusion arises from the somewhat illogical use of the word "potash" now imposed by convention. To the lay mind potash is potash, whether it be in the form of 12 per cent kainite or 80 per cent muriate of potash.[1]

The distinction of the salts is revealed by the three layers found in Figure 1. The upper layer is carnallite (potassium chloride, and when refined it is sold as muriate of potash), which is the most abundant of the potash salts in Germany, both in regards to quantity and uniformity of distribution. It is the basis of the industry. The carnallite later merges into kainite (double salt of potassium chloride and magnesium sulphate), which is the most important of the secondary minerals. It is the cheapest per ton, but the least pure. Below this layer is kieserite (sulphate of magnesia)—the safest potash fertilizer since it does not contain chloride and is thus especially adapted to soils that are inclined to be sour. It is more expensive than muriate, and for that reason not used as extensively. The layer of polyhalite is less pure, being composed of sulphate of lime and potash and magnesia. It is mined to a lesser extent. In the Alsatian field there is a layer of sylvinite (potassium chloride or muriate), which is richer in potash content than carnallite. Although this salt is found in Germany, it is of secondary origin, while it is primary in France.[2]

[1] In reporting results of analysis of potash salts, and in quoting the prices, it is evident that some standard basis of computation must be adopted. This standard is oxide of potassium, K_2O—a hypothetical compound.

[2] The principal potassium fertilizing salts are:

Salt	*Purity in Per Cent*	*Sold on Basis in Per Cent*	*Form*
Muriate of potash	80–85	80 KCL	Potassium chloride
Sulphate of potash	90–95	90 K_2SO_4	Potassium sulphate
Double manure salt	48–53	48 K_2SO_4	Potassium sulphate
Manure salt	30	30 K_2O	Double salt of magnesium and potassium chloride
Kainite		12.4 K_2O	Mostly potassium chloride

The German and the French salts are all marketed under the above headings, with the exception that French kainite has a 14 per cent purity, and a purely German product, sulphate of potash magnesia, 44–53 per cent purity and sold on a basis of 48 per cent K_2O, is added.

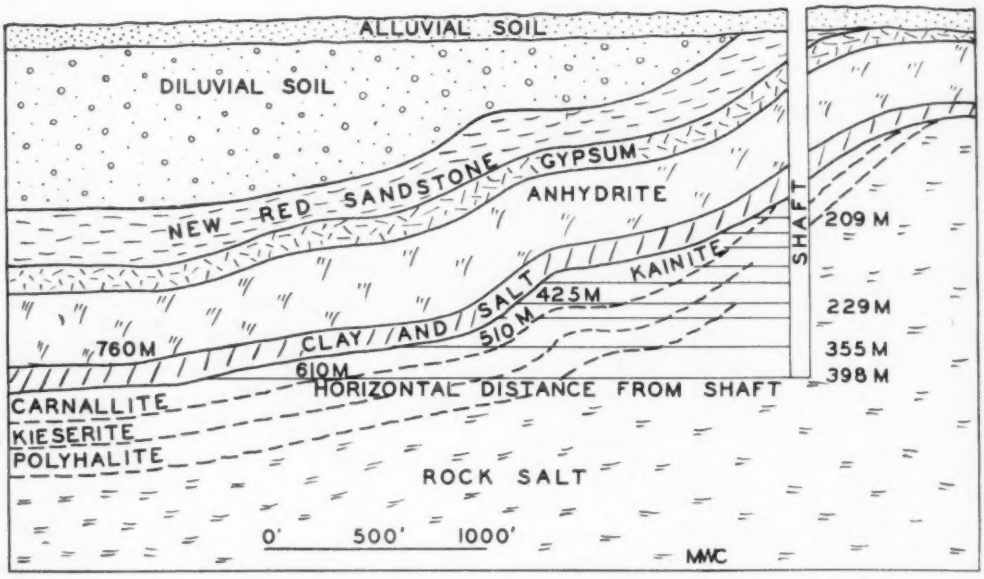

FIGURE 1.—Cross section of the salts deposit at Leopoldshall, Germany, showing the relationship of the various beds to one another, the depth at which they are mined and relative thickness of the beds. (Diagram reproduced from Savage, Wallace, *The Potash Industry of Germany*, Chemical and Metallurgical Engineering, Vol. 19, September 26, 1918, page 455.)

MINING TECHNOLOGY

The potash-bearing strata of both the German and the Alsatian mines varies considerably in their depth below the earth's surface (usually from 1,200 to 3,500 feet), and they are reached by ordinary mine shafts. In sinking these shafts the utmost care must be taken so that the impervious cap (clay—see Fig. 1) overlying the deposits remain intact, since the salts are readily soluble, and therefore easily washed or leached away. Within the mines the potash salts are broken down by blasting or drilling (Fig. 2). This breaks off large blocks of salt, which are broken up by the miners and transported in small cars to the shafts where they are hoisted to the surface. They are then taken to the refining plants for grinding and for further treatment.

Geologically these potash beds (Permian at Stassfurt and Tertiary in Alsace) represent the last stage in the evaporation of salt water, presumably sea water, of a great closed basin. The peculiar climatic and topographic conditions which caused their formation have been the subject of much speculation.

POTASH-PRODUCING REGIONS OF GERMANY

Stassfurt has been the center of the potash region since the inception of the industry in 1861, but potassium salt beds underlie practically the whole area encircling the Harz Mountains, in the provinces of Saxony, Brunswick, Hanover, and Anhalt; in the south in Thuringia and Hessen Nassau; in the North German Lowlands; in Jessenitz, and in limited quantities in Baden. It has been estimated that the reserve content of these entire deposits are in the neighborhood of some 20,000,000,000 metric tons of crude potash salts, which at the present rate of consumption

would be sufficient to supply the world's needs for a period of 2,000 years.

Throughout all of these regions high-grade deposits of potash lie near the surface that become richer with depth, down to an approximate limit of 5,000 feet. It is understood, of course, that the beds, some tilted and folded, while others horizontal, vary greatly both in regards to thickness and composition. Furthermore, in a great many places the strata are very irregular and ill-defined so that the salts shade into one another. Of all the districts, probably the most favored from the standpoint of seam structure, from that of the concentration of particular salts, and from that of potash content is the so-called Werra district in Thuringia. The Wintershall group (see Fig. 3), who are large mass producers controlling 43 per cent of the German

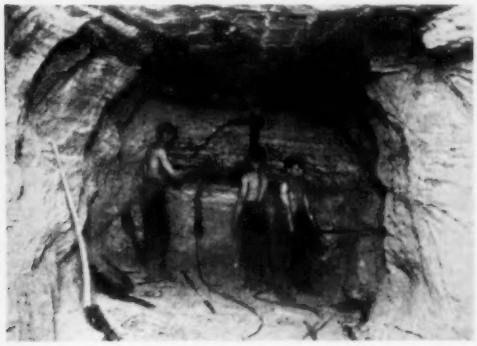

FIGURE 2.—The interior of an Alsatian potash mine. In Alsace as in Germany, highly improved drilling and mining methods are employed throughout the potash districts. (Courtesy of Société Commerciale des Potasses D'Alsace, Mulhouse.)

potash output, have concentrated production in this area, and because of the advantages existing there, plus their efficient organization, they have been able to advocate, much against the wishes of the other producers, a low price policy.

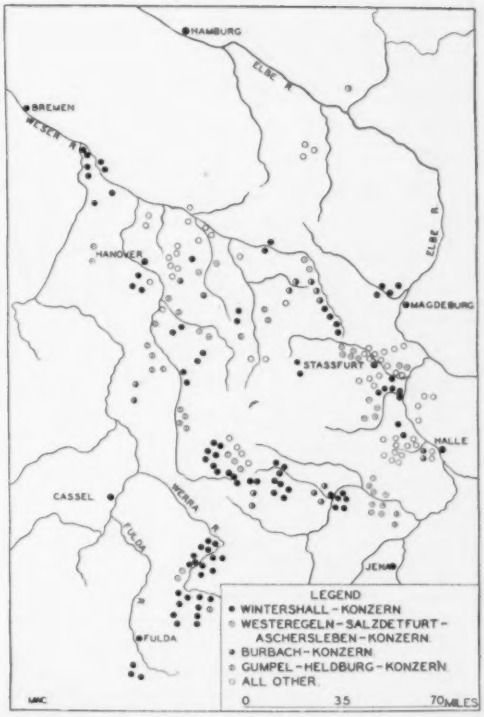

FIGURE 3.—The potash deposits of Germany are widely distributed, but some of the best production is concentrated within a relatively small area. The distribution of the principal mines and interests is herewith clearly indicated. (Diagram reproduced from Hoar, H. M., *Potash: Significance of Foreign Control and Economic Need of Domestic Development*. U. S. Dept. of Commerce, Trade Promotion Series No. 33, page 35.)

PRODUCTION

The development of the German potash industry has been phenomenal, as shown by Figure 4. In 1861 the production of crude salts amounted to but 2,293 metric tons, in 1925, 12,044,239 metric tons. Before the war Germany produced almost the entire world's supply of potash, 95 per cent coming from the German fields, and 5 per cent from the Alsatian field—then under German control. The wide fluctuations in production since 1914 are due mainly to the disorganized conditions brought about by the war, but partly also to the competition of the French who, by the Treaty of Ver-

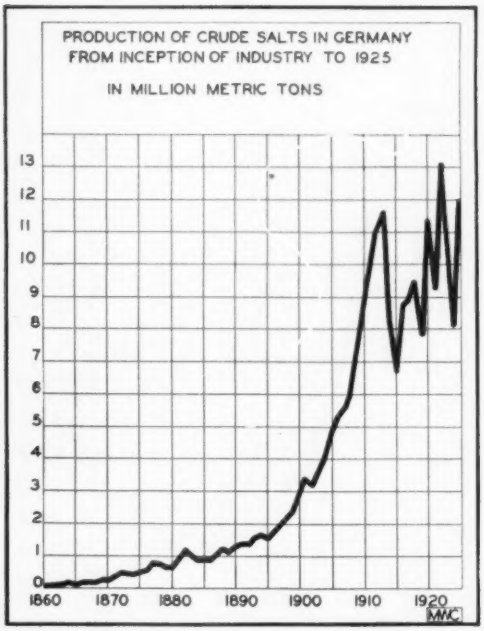

FIGURE 4.—The slow but relatively steady increase in production until 1900, and its rapid rise and sharp fluctuations since that time are well revealed in this graph. (Data from letter to writer from Deutsches Kalisyndicate, G. m. b. H., Berlin.)

sailles, obtained the Alsatian mines. This broke the German monopoly. However, open competition never materialized, for the enactment of the Franco-German Agreement in May, 1925, divided the world markets in a ratio of 30 per cent and 70 per cent respectively, and reëstablished a monopoly controlled by two independent nations. Already the industry is on the road to recovery, due partly to this agreement, but partly also to the agricultural prosperity in 1924 which enabled the farmers to purchase fertilizers.

From the beginning overproduction has been the spectre which has haunted the industry, since the high profits were a constant temptation to over-exploitation. Mergers were established from the first, but in order to best serve the interests of Germany and to preserve the monopoly, the German Government by the Potash Law of 1910 regulated the industry. Higher production costs and the Alsatian competition necessitated in 1919 the enactment of a new potash law, which vested the control of the entire potash industry in the Federal Potash Council, and, furthermore, compelled all producers to enter a union known as the German Potash Syndicate, which reserves as its sole right to sell the potash output—all of which must be placed at its disposal. This absolutely controls production and sales, and prevents competition among the German producers.

One of the most important and significant recent amendments to the Potash Law is the "closing down" act, which provides for the shutting down of works that in the opinion of the Council are unprofitable. Up to date 118 of the 224 potential mines have been closed until 1953, and approximately 70 are now fit for operation. Of these, 42 are running, while 28 are held in reserve.

This act has been largely responsible for the merging of many works, for the large producers have attempted to secure the production quotas that had been allotted by the Council to the poorer works, which since have been compelled to shut down. The Wintershall, the Westeregeln-Salzdetfurt-Aschersleben, and the Burbach Concerns now roughly control respectively 43, 20, and 8.7 per cent of the production (Fig. 3). Although this movement of concentration of production in the best mines and works may bring about reduced prices of potash, it nevertheless has created unsound conditions within the industry. Because it is impossible for the producers to compete in different markets, a struggle

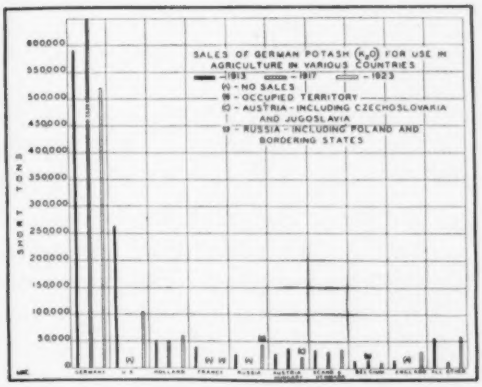

FIGURE 5.—Though German potash is sold in many agricultural countries, the great bulk of the production is utilized within the Reich itself. The fertility of the soils of Germany is thus constantly improved and maintained despite their heavy cropping. (Data from Hoar, H. M., U. S. Dept. of Commerce, Trade Promotion Series No. 33, pages 58–59.)

ensued for large quotas in the syndicate, which could only be obtained by fusion or purchase. In either case the result was increased costs, and was only profitable when the fusion or purchase price was lower than the savings effected by the increased production. It is highly probable that if free competition had been permitted, the poor works would have eventually been forced to close down.

SALES OF GERMAN POTASH

A glance at Figure 5 shows that the domestic sales have at all times exceded the exports, and that during the war, when most of the foreign trade was shut off, the German agricultural consumption was exceedingly heavy. Germany's principal export market has always been the United States. Up to the summer of 1914 the world consumed about 1,000,000 tons of potash annually, of which Germany used more than one-half, and the United States one-fourth—the latter consumption thus approximating the total of all Europe, excluding Germany. Figure 5 shows further that the sales of German potash has been confined almost entirely to the western portion of the continent, with Holland leading in the amount consumed. In general the period between 1913 and 1923 has shown very little variation, except a decline in the United States market (this has since been recovered) and the loss of the French market, which now supplies its own domestic requirements. Increased sales of French as well as German potash is anticipated, since the increasing population will demand more intensive agricultural production, dependent in turn upon an increased consumption of potash.

ALSATIAN POTASH FIELD

The French mines are located in Upper Alsace, about 20 to 25 miles north of the Swiss border in the Rhine Valley (Fig. 6). The district extends over 75 square miles, and insofar as is known at present, the deposits in this area are estimated to amount to 1,800,000,000 tons of raw salts, *i.e.* about 300,000,000 tons of pure potash.

The Alsatian potash industry can in reality be termed a post-war development. In 1913, while under German control, only one shaft was completely installed, although 18 were in operation, and the entire field was credited with but 4 per cent of the total production. However, under the French régime, and in spite of the general world disorganization as a result of the war, the output increased at once—growing from 58,000 tons of pure potash in 1913 to 300,000 tons in 1925. With the exception of the business depression in 1921, the growth, as shown in Figure 7, has been vigorous and continuous due to:

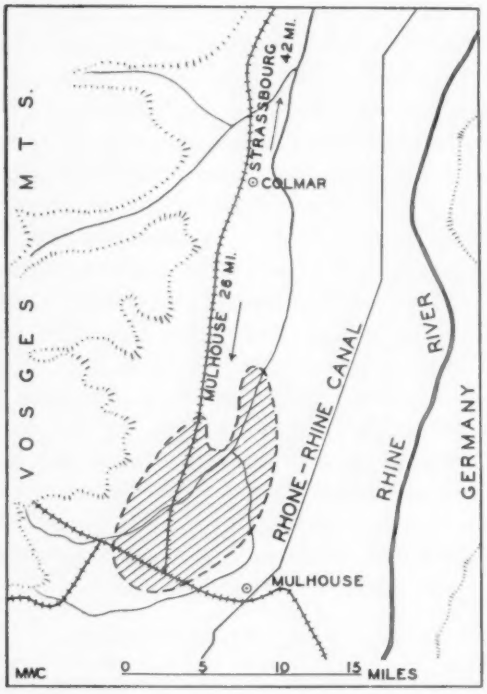

FIGURE 6.—The Alsatian potash field, indicated by the shaded area, and valley of the Rhine in the vicinity of Mulhouse. (Diagram reproduced from Gale, H. S., *The Potash Deposits of Alsace*. U. S. Geological Survey, Bulletin No. 715, page 18.)

1. The geographical situation of the mines, which easily permits the shipment of potash by the use of the navigable Rhine. They also have good railway facilities.
2. The high grade of the salts. By selection it is possible to obtain a salt averaging 30 per cent K_2O, which in other countries is only secured by refining.
3. In marked contrast to the German mines, any inflow of water into the mines does not entail permanent abandonment.
4. The logical and careful development of the mines, care being taken to avoid the sinking of too many shafts, thus preventing overproduction.

The German producers, on the other hand, possess several advantages, viz.:

1. The presence of kieserite, used in the production of potassium sulphate and potassium magnesium sulphate. This salt is absent completely from the Alsatian deposits.
2. More mines and refining plants.
3. The absence of clay, which in the Alsatian deposits is a handicap in refining.
4. Greater accessibility to the sea.

As in the case of the German sales, the French, too, have the United States as the principal importer, for, as noted on Figure 7, the amount is equal to that exported to all the other countries, mainly Holland, England, and Belgium, and to a lesser extent Sweden and Denmark. Although the French potash production and sales seems rather insignificant when compared with that of Germany, it nevertheless is in a position to offer the latter serious competition. The Franco-German Agreement would justify such a statement. If needed, France's reserves would enable her to supply the world with potash at the present rate of consumption for 200 years. Its greatest market at present is the domestic one, where consumption has already increased from 45,000 tons of K_2O in 1919 to 120,000 tons in 1925.

OTHER EUROPEAN SOURCES OF POTASH

It will be remembered that the Germans and the French supply 95 per cent of the world's potash supply, which leaves but an insignificant

amount to others. Of the latter, Poland leads with a total production of 81,420 tons of crude salts. The reserves being limited, this area will probably never seriously compete with France or Germany other than their loss of the Polish market.

Although much has been written on the rich potash deposits of Spain, from the facts known at present it is unlikely that the Spanish deposits will have any significant influence on the world potash situation. At the present time there is only one company in operation, and only a few thousand tons have been produced. Spain may, however, be a potential source of potash, and it should, therefore, be kept in mind.

From the standpoint of world markets, all other European sources of potash are trivial. Italy manufactures some potash from the insoluble minerals, alunite and leucite; England and Sweden from the blast furnaces and cement plants; Ireland from the kelp ashes, and Russia from the sunflower; but, in all cases, any marked increase in consumption would have to be supplied from a foreign source.

The approximate distribution of potash deposits according to present knowledge is as follows:

	Raw Material	*Percentage of Potash (K_2O) in Crude Salts*	*Reserve in Tons K_2O*
Germany	Salt	15	2,000,000,000
Alsace	Salt	22	300,000,000
Searles Lake, Calif.	Brine	7	20,000,000
Spain	Salt	15	530,000
Nebraska	Brine	25	500,000
Abyssinia	Salt	24	200,000
Galicia	Salt	10	40,000

The distribution of the world's production of potash in 1925 (total

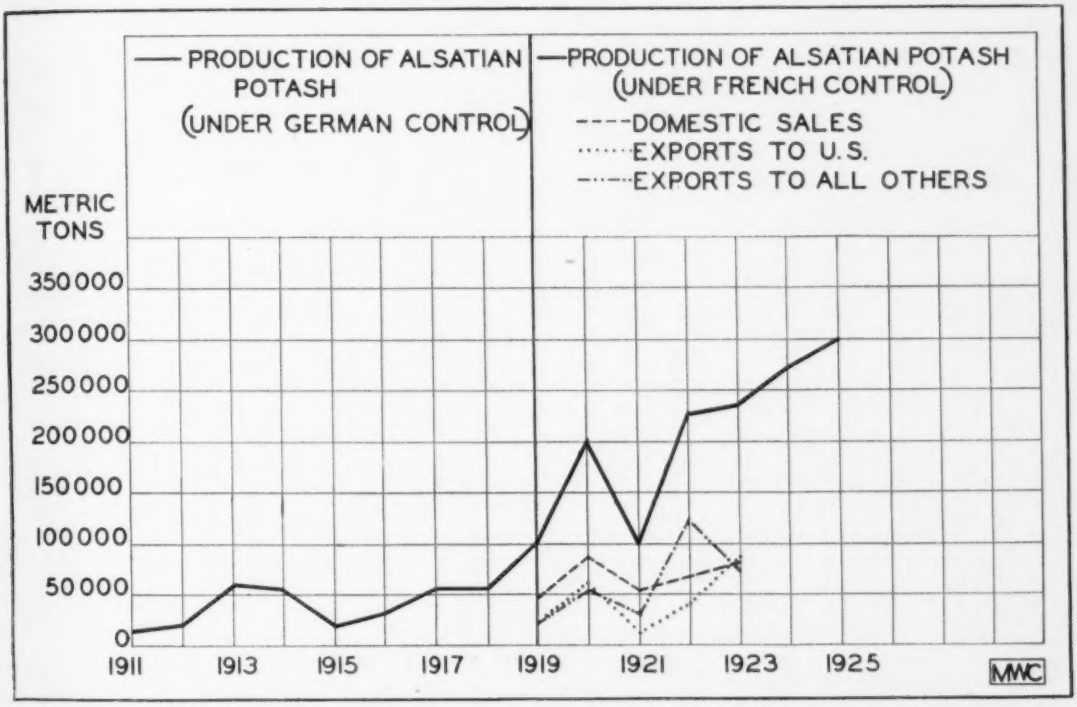

FIGURE 7.—The production of Alsatian potash deposits under their control by the French since the close of the world war has trebled, and French soils have been correspondingly enriched. (Data from U. S. Dept. of Commerce, Trade Information Bulletin No. 18; from Hoar, H. M., Trade Promotion Series No. 33; and from Mineral Resources of the United States, 1924, Part II.)

1,600,000 metric tons) is approximately as follows:

	Metric Tons K_2O
Germany	1,225,500
France	300,000
United States	30,000
Poland	25,000

UTILIZATION

Agriculture consumes about 90 per cent of the potash produced (Fig. 8). It is a very necessary constituent of fertilizer, being absolutely essential for the light sandy soils and the peaty meadow lands, as well as for certain potash consuming crops, such as potatoes, tobacco, cotton, and the root crops, since the soils mentioned are deficient in this element, while the crops named require it in larger proportion than do the others. Clay soils are rich in potash, but often the proportion immediately available for plant food is small, since the potash is frequently in combination with silica so as to form a compound that will not dissolve in water, or will do so but slowly. To these soils, also, potash should be added. The countries with intensive agricultural production are the chief purchasers of artificial fertilizers.

Industrially, the potassium salts are used in the manufacture of soap, certain kinds of glass, matches, some explosives, chemical reagents, fireworks, medicines, dyeing, tanning, electroplating, and photography. The sales of potash to the industrial and manufacturing concerns is only about 10 per cent of the total, which in 1913 amounted to approximately 106,456 metric tons. Germany with her great chemical industries consumed 68,180 tons of this, the United States only 11,411 tons. Figure 8 shows that the use of the potassium salts in industry has been comparatively uniform throughout the years, and that while an increase in consumption since the depression is evident, the amounts employed by the industries in foreign countries is but slight as compared with that of Germany. The chief difference between the agricultural and industrial consumption is that while the former is increasing progressively, the latter is consuming but a trifle more than it did at the inception of the industry.

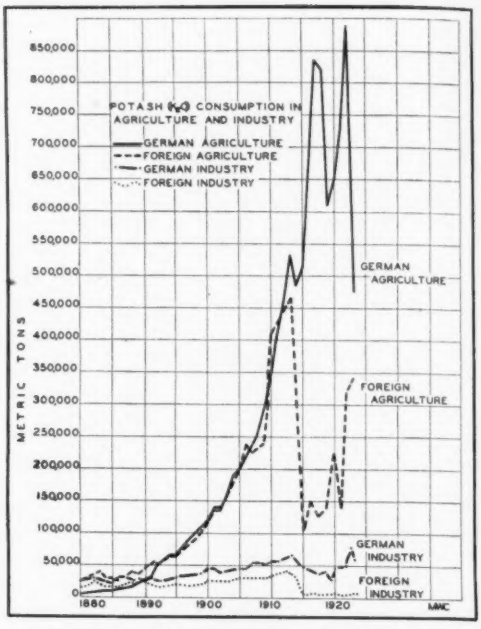

FIGURE 8.—The proportion of potash production going into agriculture has increased rapidly since 1900, whereas the proportion utilized in industry has remained fairly constant. (Data from letter to the writer from H. C. Claiborne, U. S. Consul in Charge, Frankfort on Main, Germany.)

THE SUGAR INDUSTRY OF THE BRITISH WEST INDIES AND BRITISH GUIANA WITH SPECIAL REFERENCE TO TRINIDAD

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THE sugar industry has ever been the shuttlecock of politics and its extent and localisation have been determined more by this factor than by economic considerations. The sugar industry of the British West Indies and British Guiana has by no means been immune from these political influences.

Historical Introduction

Sugar production in these Colonies soon succeeded an original diversity of crops and, with its laborious processes, involved a rapid extension of the lucrative slave trade. With a monopoly of the English market, this industry proved extremely profitable and made the fortunes of many distinguished English families. The wealth of the planters was reflected in their extravagant modes of living, their "Great Houses," luxurious furniture, and costly plate. Absentee proprietors acquired an influence in the deliberations of Parliament which ensured the favourable consideration of their interests; indeed, it may be claimed that their activities were more profitable at Westminster than they could have been in the West Indies. In spite of minor setbacks the period was one of exceptional prosperity.

But this did not continue, and the nineteenth century records a dreary succession of political blows, the cumulative effect of which threatened the existence of the industry. The prohibition of the slave trade by the British in 1807, followed by the abolition of slavery in 1834, left the estates with a disorganised labour force which resulted in diminished production.[1] Even compensation amounting to £16,000,000 proved insufficient to readjust the industry to new conditions.[2] Finally the plantation owners' waning political power was shattered by the English Reform Bill of 1832.

Slavery was continued in the foreign West Indian islands and Brazil, but British producers were assisted by a discriminating tariff levied against slave-grown sugar. In 1846 this differential duty was lowered and then abolished. Costs of production in the British Colonies had doubled after the abolition of slavery and, in the absence of a protective tariff, the position became precarious.[3]

The "plantocracies" in the islands and British Guiana endeavoured, with little success, to remedy the labour

[1] Sugar exports from Jamaica fell from 150,000 hogsheads in 1805 to 89,000 hogsheads in 1834 and to 30,000 hogsheads in 1865. Pitman, *The Development of the British West Indies*, page 63, Yale University Press.

[2] The Commissioners estimated the value of the slaves at £34 million, and the capital valuation of the industry at £219 million.

[3] In evidence before the Committee of Sugar and Coffee Plantations in 1848 it was stated that the cost of producing muscovado sugar in Antigua rose from 7/6d. per cwt. under slavery, to 16/6d. with free labour; in Barbados from 6/– to 15/6d. per cwt.; and in British Guiana to 25/–. Costs of production in Cuba and Porto Rico during the latter period were estimated at 8/–and 8/6d. per cwt., respectively. Beet sugar was not at this time a serious competitor and is said to have cost 24/4d. per cwt. to produce.

shortage by sporadic recruitments from Madeira, St. Helena, Sierra Leone, Malta, Germany, and other places. In 1845, following the example of Mauritius, began that steady flow of indentured immigrants from India, which continued, almost without intermission, until 1917 when the Government of India terminated the process was discontinued.[4] With indentured labour and other assistance, a moderate degree of prosperity was restored.

Another factor was introduced when the rapid expansion of the beet sugar industry brought a threatening and formidable competitor into the field. Aided by protective tariffs

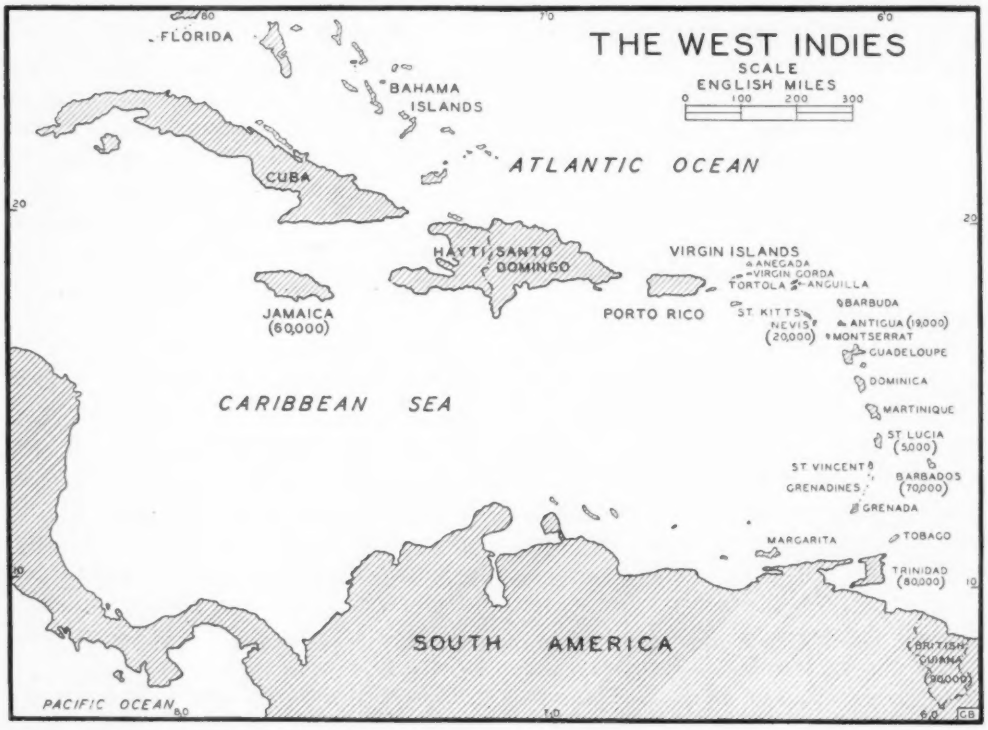

FIGURE 1.—The Caribbean region, showing the location, and sugar production, in brackets, of the principal British islands and British Guiana.

system in response to national feeling. While the earlier methods of recruitment left much to be desired progressive amendments removed the worst abuses and subsequent enquiries revealed the system in a favourable light. Chinese labourers, who made excellent agriculturists, were also recruited, but on the score of expense, and in view of the fact that they found more profitable scope for their aptitude in other spheres, the and organised in cartels or trusts, the industry secured sufficiently high prices in the home markets to enable it, with the assistance of export bounties, to undersell cane sugar. Ger-

[4] Chinese emigration was almost entirely male, tradition binding the women to the ancestral village. Between 1853 and 1913, 15,720 Chinese immigrants were introduced into British Guiana, of whom 13,485 were males and 2,235 females. In 1911 there remained 1,481 males and 1,141 females, the rapid decrease being due to a readjustment of the sex ratio by male emigration. See Campbell, *Chinese Coolie Emigration*, King; and Clementi, *The Chinese in British Guiana*.

many alone paid $351,000,000 in sugar export bounties between 1840 and 1903.[5] The unprotected cane sugar industry of the British West Indies and British Guiana felt this competition severely during the seventies, and the position became acute during the eighties when many estates changed hands at greatly reduced valuations. Table 1 indicates the rapid relative rise of beet sugar production.

TABLE 1

WORLD PRODUCTION OF SUGAR *

Period	*Average Annual Production* (In 1,000's Metric Tons)	*Percentage of Total* *Cane*	*Beet*
1850–1851	1,507	90.6	9.4
1859–1860	2,127	79.5	20.5
1860–1870	2,323	71.4	28.6
1870–1880	3,357	58.6	41.4
1880–1890	5,242	47.8	52.2
1890–1900	8,296	41.2	58.8
1900–1910	12,578	42.4	57.6

* Excluding India throughout since estimates for this country are not available prior to 1898–1899. Unless otherwise stated, 1 ton = 2,240 lbs.

The situation was aggravated by the declining value of the sugar by-products, molasses and rum, caused by modifications in taste, the cheap price of sugar, and fiscal changes in Martinique and the United Kingdom.[6] Some relief was afforded by the abolition of slavery in Cuba in 1886, and the McKinley Tariff of 1890 by which the United States of America imposed a small discriminating duty against European subsidized beet sugar. Prices, however, continued to decline and British cane sugar was rapidly being ousted from the United Kingdom market by Continental beet sugar.

[5] It is claimed that the indirect benefits to agriculture more than compensated for this expenditure and for the higher price of sugar paid by the German consumers. $1 = 4/2d. sterling; 1 cent = ½d.

[6] The value of molasses and rum exported from St. Kitts-Nevis declined from £42,353 in 1882 to £8,903 in 1896. *W. I. R. C.* Report, page 57.

Table 2 shows that the price in 1896 was only half that of 1881.

TABLE 2

CANE SUGAR PRICES †

Year	*Price* (In Shillings per Cwt.)
1881	21.72
1884	16.41
1887	12.53
1890	13.33
1893	14.20
1896	10.85

† Unrefined sugar. Figures extracted from *W. I. R. C.* Report, App. C, Part 1, page 196.

Table 3 indicates the decline in the United Kingdom's import of sugar from the British West Indies and British Guiana, and the rapid increase in the import of beet (chiefly refined) sugar.

TABLE 3

IMPORTS OF SUGAR INTO THE UNITED KINGDOM *

(Quantities in 1,000's tons)

Year	*Cane Sugar* *British West Indies and British Guiana*	*Total*	*Beet* *Refined*	*Total*	*Total Beet and Cane*
1882	198	732	133	398	1,130
1886	99	539	247	586	1,125
1891	54	376	540	1,001	1,377
1896	72	382	738	1,144	1,526

* Figures extracted from *W. I. R. C.*, App. C, Part 1, page 195.

By the Dingley Tariff Bill of 1897 a duty, equal to the amount of the bounty, was imposed upon beet sugar with the result that the United States replaced the United Kingdom as the principal market for sugar from the British West Indies and British Guiana.

A serious outbreak of sugar cane disease about 1890, which spread with amazing rapidity and intensity throughout the islands, threatened the very existence of the industry. Losses of cane, estimated at between 25 and 50 per cent were reported from most of the islands during 1892–1894, and later from British Guiana. It is believed that with the active interchange of cane varieties then taking place this disease, caused

by *Colletotrichum falcatum*, was introduced from the East by a resistant variety. The Bourbon cane, then in general cultivation, proved highly susceptible.[7] Immediate measures were taken to replace the Bourbon

FIGURE 2.—The extensive and important sugar production of Trinidad is localised along the western edge of the island, where climate and soil are most favourable.

cane by White Transparent (or Caledonian Queen) and other more resistant varieties.

In the meantime a development of the greatest importance to the cane sugar industry was taking place in Barbados. In January, 1888, an overseer, Mr. I. B. Pilgrim, noticed some young seedling canes growing in a field adjacent to some experimental cane plots.[8] It had been thought that by long vegetative propagation the sugar cane had lost the power of producing viable seed. Harrison (the late Sir John) and Bovell, immediately appreciating the commercial importance of this discovery, vigorously prosecuted the production of seedling canes which were substituted for existing varieties immediately they gave sufficient agricultural promise.[9]

Planters reduced their costs by operating on a larger scale and introducing manufacturing refinements. A few scattered examples will indicate the widespread nature of this movement. In Trinidad, between 1889 and 1896, 88 factories were reduced to 39;[10] in British Guiana 230 in 1829 to 180 in 1849, and 64 in 1896;[11] and in Tobago 65 in 1862 to 38 in 1896.[12] Considerable sums were expended in modernising these factories and as many proprietors succumbed in the process their places were taken, in some cases, by companies with wider financial resources. For example, the Colonial Company, between 1870 and 1895, spent £339,000 in improving its machinery and transport in British Guiana and Trinidad, excluding the original cost

[7] See Nowell, *Diseases of Crop Plants in the Lesser Antilles*, pages 297–301.

[8] The same rediscovery was made independently and almost simultaneously in Java where the matter was regarded as merely of academic interest until a serious outbreak of Sereh disease attacked the black Cheribon variety.

[9] Every known variety of cane is a highly complex hybrid, the characters of which segregate and recombine in its seedling progeny in almost every conceivable variation. In rare cases these seedlings possess a better combination of characters than their parents. See, *Tropical Agriculture*, Sugar Supplement, Vol. 4, No. 9, page 14, Trinidad.

[10] Lamont, Sir Norman, Bt., *Tropical Agriculture*, Vol. 5, No. 7, page 167.

[11] *W. I. R. C.* Report, page 83.

[12] *Op. cit.*, page 107.

of its Trinidad factory (£213,000).[13] British Guiana during 1880–1895 imported sugar machinery to the value of £1,307,500,[14] while the Government of St. Lucia loaned £40,000 between 1874 and 1877 for the modernisation of the Cul-de-Sac factories. One small Trinidad estate, Palmiste, between 1883 and 1894 spent £52,600 in reconstructing and modernising its factory and transport facilities.[15]

These improvements considerably lowered the cost of manufacture; for instance, those of the Colonial Company, Ltd., in British Guiana were reduced from £9, 15s. per ton in 1883–1884, to £4, 15s. in 1895–1896, and in Trinidad from £8, 9s., 5d. in 1883, to £3, 11s., 5d. in 1896.[16] Further economies resulted from these improved factories since they not only took a smaller quantity of cane to produce a ton of sugar, but also produced a grade of sugar realizing £3 per ton more than Muscovado.[17]

However, in the cultivation of cane, lack of scientific knowledge and the absence of suitable mechanical power precluded any similar economy. Wages, the principal item, were reduced by amounts varying from 10 to 25 per cent, and further temporary reductions were effected by allowing houses and other buildings to fall into serious disrepair,[18] and by neglecting all save imperative operations. Despite these efforts many proprietors were forced to sell their estates at rapidly declining values, while in some islands, estates were completely abandoned and allowed to revert to bush.[19]

In 1882 the exports of the British West Indies and British Guiana totalled £8,224,000, to which sugar contributed £6,884,000, or 84 per cent. By 1896, with the fall in the value of sugar, and notwithstanding the introduction of other crops and industries, the total exports had declined to £6,106,000 of which £3,251,000 or 53 per cent was represented by sugar.[20]

By 1896 the industry was on the verge of collapse, and the situation became so critical that the Imperial Government appointed a Royal Commission of enquiry. The Commission, emphasising the vital importance of the sugar industry, recognised that the abolition of the bounty system would afford the greatest measure of relief. Perhaps the most important result of the Commission was the formation, at Imperial expense, of the Imperial Department of Agriculture, which so stimulated and coördinated scientific agricultural activity in the British West Indies, that it established a previously unknown feeling of confidence. The Department introduced more profitable al-

[13] *W. I. R. C.*, App. C, Part 1, page 178.

[14] *W. I. R. C.* Report, page 28.

[15] Lamont, Sir Norman, Bt., *Tropical Agriculture*, Vol. 5, No. 7, page 167.

[16] *W. I. R. C.* Report, page 84 and App. C, Part 1, page 178. The term "cost of manufacture" is not defined so that comparison with present-day figures is impossible, but these figures may be regarded as relatively correct.

[17] *W. I. R. C.*, App. C, Part 1, page 183. When vacuum pan sugar is made, the molasses is inferior to that of the muscovado process.

[18] *W. I. R. C.* Report, page 54.

[19] In Barbados 547 sugar estates changed hands between 1851 and 1896. Between 1871–1880 and 1890–1896 the average price fell from £59 to £31 per acre (*W. I. R. C.* Report, page 54). In St. Vincent a very large area of the best lands were in the hands of a few proprietors who had abandoned or were unable to cultivate a large proportion. The Government subsequently obtained possession of this land and divided it into small holdings (*W. I. R. C.* Report, App. A, page 121).

[20] *W. I. R. C.* Report, App. B, page 157. Excluding Jamaica, whose sugar industry had already declined in importance, the figures for 1882 were, total exports £6,752,000; sugar £5,974,000 or 88 per cent. In 1896, again excluding Jamaica, and the gold industry of British Guiana, exports amounted to £3,945,000; sugar, £2,951,000, or 75 per cent.

ternative crops, and stimulated the reorganisation of the diminished sugar industry.[21] The Imperial Government subsidised the Colonial Governments when necessary by meeting the public deficits until 1912 when the improved economic condition removed such necessity.

The industry received a powerful impetus from the abolition of the Bounty System by the Brussels Convention in 1902. The Convention took effect as from September 1, 1903, and the Imperial Government made a grant of £250,000 to assist these British Caribbean sugar producers during the interim. These indications of the revival of interest in the British West Indies and British Guiana by the Imperial Government encouraged the sugar planters in Antigua, St. Kitts,[22] and other colonies to centralize their factories.

Unfortunately, for British interests the Reciprocity Treaty of 1903 gave Cuba a monopoly of that portion of the United States market not catered for by her internal and insular production. This, coupled with the flow of American capital into the island resulted in such an amazing development (see Table 4) that the British producers in the Caribbean region were not only completely shut out of the United States market, but also had to face increasing competition in the unprotected market of the United Kingdom.[23]

TABLE 4

CUBAN SUGAR PRODUCTION

Period	*Amount* (In Short Tons)
1899–1900	345,568
1902–1903	1,118,724
1912–1913	2,719,961
1922–1923	4,035,259
1924–1925	5,125,970

[21] In Tortola, Montserrat, Nevis, Dominica, Grenada, and Tobago, sugar production, once the staple industry, is now negligible.

[22] Gunthorpes Central Factory, Antigua, planned in 1903, reaped its first crop in 1905. The St. Kitts (Basseterre) Factory was opened in 1912.

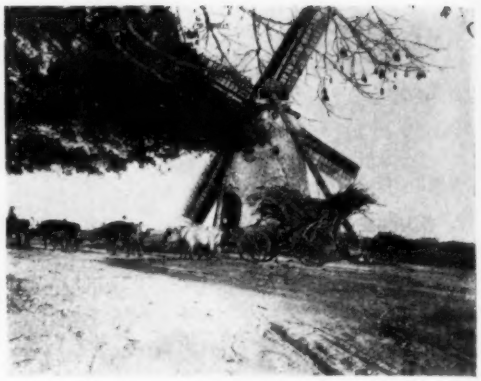

FIGURE 3.—A windmill sugar factory, Barbados, now abandoned. Each small estate formerly had its own factory. Note the method of transporting cane to the factory.

In 1898 Canada had voluntarily granted the British West Indies a preference of 25 per cent of the raw sugar duty, increased to 33⅓ per cent from July 1, 1900, and to 37½ per cent from April 1, 1907. Before the abolition of the bounties and the granting of a preference to Cuba, the British West Indies had found a more favourable market in the United States, but from this period increasing supplies were diverted to Canada. A brief sketch will indicate subsequent relations with Canada. In 1912, by a ten years' reciprocal agreement, the British West Indies were granted an additional preference on raw sugar.[24] At the same time concessions granted to Canadian refiners in 1907 and 1909, which had diminished the preference, were repealed. By a second conference in 1920 the preference was increased to 84 cents per 100 pounds for sugar of 96°.[25]

[23] Cuba now has to dispose of 1,500,000 to 2,000,000 tons of sugar outside the United States, the United Kingdom being her next best customer.

[24] *Cmd. 6092.*

[25] *Cmd. 864.* To protect the interest of Canadian refiners, the full duty, and the preference to a smaller extent, increases rapidly with higher

Again in 1925 the preference was increased to $1.00 for sugar of 96°. As a result, the Canadian sugar market has been of increasing importance to the British West Indies and British Guiana.

When the Liberal Government came into power in 1906, it soon intimated that, while it did not desire to give bounties or to see their revival, it was contrary to its policy to impose countervailing duties or to prohibit the import of bounty sugars. Russia, the only important bounty-giving country outside the Convention, was conditionally persuaded to adhere to the Convention, while Great Britain was released from the Penal Clause, and in this way the danger to the Colonies of a revival of the bounty system was averted.

In 1912 the High Contracting Parties renewed the Convention until 1918, Great Britain withdrawing in 1913. In 1917 France notified withdrawal, and in 1918 Great Britain formally withdrew its pledge of 1902 not to give a tariff preference to Colonial sugar. By this action the Imperial Government was free to grant in 1919 a preference of one-sixth of the full duty to imported British sugar, increased in 1925 to one-third, and stabilised on the basis of £3, 15s. per ton of sugar of 96° for a period of ten years. At the same time bounties, exceeding any ever given by Continental Governments, were conferred on home grown beet sugar. This small preference on British cane sugar has been the salvation of the sugar industry of the British West Indies and British Guiana, and its stabilisation for a period of ten years has provided a security which has encouraged improvements of a capital nature.

As Table 5 indicates, production diminished slowly but steadily until the outbreak of the war, when the stimulus of high prices resulted in a rapid increase. Unfortunately the demands of the belligerents prevented the profits thus obtained from being utilised in improving the factory and other estate equipment, with the result that the properties depreciated, rather than appreciated, in real value. By the time normal supplies could be resumed the industry was involved in the slump of 1921. Increased scientific knowledge, aided by a stabilized preference, have encouraged the estates to begin a tedious and painful reorganisation with which they can face the future with a chastened and modest degree of hope.

TABLE 5

PRODUCTION OF SUGAR IN THE BRITISH WEST INDIES AND BRITISH GUIANA

Period	*Annual Average in Tons*
1902–1905	249,000
1906–1909	229,000
1910–1913	198,000
1914–1917	262,000
1918–1921	227,000
1922–1925	241,000

PRINCIPAL CHARACTERISTICS OF THE BRITISH WEST INDIAN SUGAR-PRODUCING ISLANDS AND BRITISH GUIANA

The following brief accounts indicate the principal local characteristics of the more important sugar-producing islands and British Guiana, and illustrate the wide range of conditions under which cane can successfully be cultivated. At one time sugar formed the staple crop of all the islands but the depression during the nineteenth century compelled those

degrees of polarisation. The polariscope scientifically determines the sucrose content of sugar. The "Dutch Standard" hitherto maintained by Canada, but regarded as an anachronism in sugar circles, consisted of a series of sugars ranging in colour from white to almost black, and numbered from 1 to 32.

which were unable to centralise their sugar production to a sufficient degree to resort to other crops. The diversification of crops now cultivated has thrown into relief those natural differences which were cloaked by the universal cultivation of sugar cane.

JAMAICA

Jamaica, the largest of the British West Indian Islands, with a population of 858,000, has an area of 4,450 square miles, the extreme length being 144 miles, and the greatest width 49 miles. The main divide trends from east to west with spurs running northwest and southeast, the latter culminating in the Blue Mountains with a maximum height of 7,388 feet. The surface is cut up into a complex series of ridges, with intervening gullies, liberally supplied with rivers, streams, and springs. Geologically the island exhibits considerable diversity, consisting of an igneous rock foundation overlaid with several distinct formations. The sugar industry is located mainly in the extensive alluvial flats of the parishes of Clarendon and St. Catherine, in the county of Middlesex; in the alluvial deposits and marl beds of the parish of Westmoreland, and in the alluvial valleys of the Trelawney and Hanover in the county of Cornwall; and, more recently, in St. Thomas in the east, in the county of Surrey. The average annual rainfall is 76 inches, varying from 105 inches in the northeast to 54 inches in the south. Production has risen rapidly from 14,000 tons pre-war, to 36,000 tons during 1920–1924, with an estimate of 64,000 tons in 1926. Of 42 factories only one produces 8,000 tons and 26 less than 1,000 tons. The production of rum is a dominant characteristic of the industry. There is a tendency towards centralised sugar manufacture from canes grown by independent estates, though the configuration of the country is a handicap. Other and more profitable industries, particularly banana growing, have diverted capital and labour from sugar production.

ST. KITTS

St. Kitts (or St. Christopher) has a population of 22,000 (1921 census), an area of 68 square miles, and is about 19 miles in length, with an average width of 5 miles except in the narrow southeast peninsular plain where the capital, Basseterre, with a population of 9,000, is located. The main range of rugged mountains, clothed in forest and tree ferns, runs northwest-southeast, culminating in the volcanic cone of Mt. Misery (3,711 feet), and conserves the rather deficient annual rainfall of 45–50 inches. From the low sea cliffs gentle slopes of detrital volcanic material rise to about 1,200 feet planted to a maximum height of 800 feet to 1,200 feet mainly in sugar cane. The soil is light and deep, being particularly easy to work, but is susceptible to water shortage and rapidly loses fertility unless manured. The lower slopes are traversed by deep ravines, while most of the mountain water finds it way underground. Sugar remains the principal crop, the whole of the increasing output of nearly 20,000 tons being manufactured by the St. Kitts (Basseterre) Sugar Factory, Ltd., opened in 1912. Cane transport around the island has been rendered easy by road and estate railway. Yields average a little over 20 tons of cane per acre, while the sucrose content is high, and extraction efficient, an average of 8.58

FIGURE 4.—A muscovado factory, Antigua, illustrating another stage in the evolution of modern sugar manufacture. Note the hand fed carrier which conveys canes to the mill.

tons of cane being required to produce one ton of sugar during 1925 and 1926. There is no extensive class of peasant cultivators.

Some seasonal labourers are recruited in the neighbouring island of Nevis where the coarse boulder formation of the lower slopes necessitates costly hand labour and results in low yields of cane, small quantities of which are shipped to St. Kitts.

ANTIGUA

Antigua is irregularly oval in shape, having an area of 108 square miles, and a population of 29,000. The steepness of the southwestern volcanic hills renders them unsuitable for cane cultivation. The highly calcareous soil of the northeast hills is usually sufficiently heavy to be fertile when well tilled and drained. The heavy clay soils of the Central Plain in some districts form excellent cane land when liberally manured and well drained, but the occurrence of salt patches renders some of the lands unsuitable for cane cultivation. The low annual rainfall of 45 inches is a serious factor, but is partly offset by the retentiveness of the soil. The bulk of the island crop, which recently increased rapidly, is manufactured by the Gunthorpe's factory, which in 1927 turned out a record of 19,000 tons of sugar. The estates contributing cane possess some financial interest in the factory. Yields of cane per acre are not high but both sucrose content and extraction are good, an average of 8.76 tons of cane producing 1 ton of sugar during 1926 and 1927.[26]

ST. LUCIA

St. Lucia has an area of 233 square miles, with a maximum length of 24 miles, a maximum breadth of 12 miles, and a population of 56,700. The island is volcanic, the main ridge of mountains traversing the island from north to south at a height of 1,500 feet, with peaks exceeding 3,000 feet in the southwest part. Ridges from the central range provide narrow, well-sheltered valleys in which discontinuous areas, totalling 4,750 acres, are under sugar cane. Four factories, each situated in a well-watered valley, produce a total of about 5,000 tons of sugar and a varying quantity of syrup or fancy molasses. There is at present a tendency to extend cane cultivation by irrigation and by breaking up new lands. The introduction of new varieties of cane, and coöperation between the factories is likely to increase production and efficiency, but transport difficulties hinder expansion or further centralisation.

BARBADOS

Barbados is a sugar-producing island of exceptional interest. With an area of only 166 square miles it supports a population of 156,000 or 940 to the square mile. The island is flat but rises by wide terraces to a maximum height of 1,100 feet. The surface rock consists of coral lime-

[26] This is nearly twice the yield of the old muscovado process.

stone except in the northeastern, or Scotland, district, where the underlying estuarine and oceanic beds of sandstone, clay, and chert are exposed. In the porous limestone areas streams are absent or subterranean. The rainfall varies between 50 inches and 70 inches and the heavy retentive red and black clay loam soils require and receive frequent thorough cultivation and heavy applications of pen, imported sheep, and artificial, manures. Sugar remains the predominant product, the equivalent of about 70,000 tons being annually produced, of which a large, but variable, proportion is exported as syrup or fancy molasses to the North American market. Favoured by a healthy climate, fertile soil with good natural drainage, a large and comparatively energetic labouring population, and locally raised seedling canes of high sucrose content, the estate proprietors have maintained an intensive cultivation of the soil. Ratoons are the exception, cane being frequently rotated with food crops, such as yams, sweet potatoes, eddoes and maize, or fodder crops such as guinea corn and Imphee, or "cash" crops such as cotton. Although favourable agricultural factors enabled planters to resist the trend towards centralisation of manufacture, the 440 factories of pre-war days have now been consolidated into about 250. There is a tendency for planters to maintain their agricultural independence and sell their canes to a convenient large factory except when a high price for syrup renders the operation of their own antiquated mills profitable. Further centralisation with greater security of supply to the factory appears inevitable. Cane yields are relatively high, sucrose content exceptionally good, but in some of the smaller factories extraction is low. The planters are partly financed by the Sugar Industry Bank. The Imperial Government granted £80,000 to enable the industry to tide over the depression, pending the abolition of the bounty system by the Brussels Convention. This sum was not distributed among the individual plantation owners, as intended, but was kept intact and used as the nucleus of a Sugar Industry Bank. The original sum now amounts to £180,000.

BRITISH GUIANA

British Guiana, on the mainland of South America, contrasts in many ways with the varied conditions of the islands. With a coast line of 250 miles, a maximum depth of 600 miles, and an area exceeding 90,000 square miles, she supports a population of only 298,000, of which nearly 40 per cent are East Indians. The cultivated area of about 200 square miles is confined to the coastal alluvial flat, some ten miles in depth, and the banks of certain rivers for some distance inland. A considerable area of this coastal sugar belt is below spring tide level and has to be protected by elaborate and costly sea defences which, with canals and sluices, keep out salt water and drain, sometimes by pumping, accumulated fresh water during the wet season. The soils are stiff or plastic impermeable clays with varying percentages of silt underlaid by silt or sand. Locally termed "pegasse" soils possess a distinct black surface layer up to 5 feet in depth formed by decomposed forest material or reeds and rushes. The soils are strongly acid in reaction. Drainage presents the most difficult problem, the land being divided by the main naviga-

tion canals some 20 feet wide, the main drains, and the elaborate systems of subsidiary drains, which hamper mechanical tillage. The cane is drawn by animals or tractors along the navigation canals in scows or punts, each 50 feet long and 4 feet deep, holding 12 to 15 tons of cane. Cable drawn implements are operated from punts. Humus is deficient except in the best "pegasse" soils and among other remedies recourse is had to flooding temporarily abandoned fields. Plant canes give high yields and 3 to 5 ratoons are reaped. Exports of sugar during 1920–1924 averaged 90,000 tons per annum, there being 39 factories in 1922 with a cultivated area of 61,000 acres. The crop is spread over two periods: February to June, and September to January. Shortage of labour hinders existing plantations and prevents rapid expansion. The Colony is famous for its "Demerara Crystals," which, originally a product of the Bourbon cane, are now produced to some extent in the islands, and, it is to be regretted, improperly imitated outside the West Indies by dyeing sugar produced by different processes.

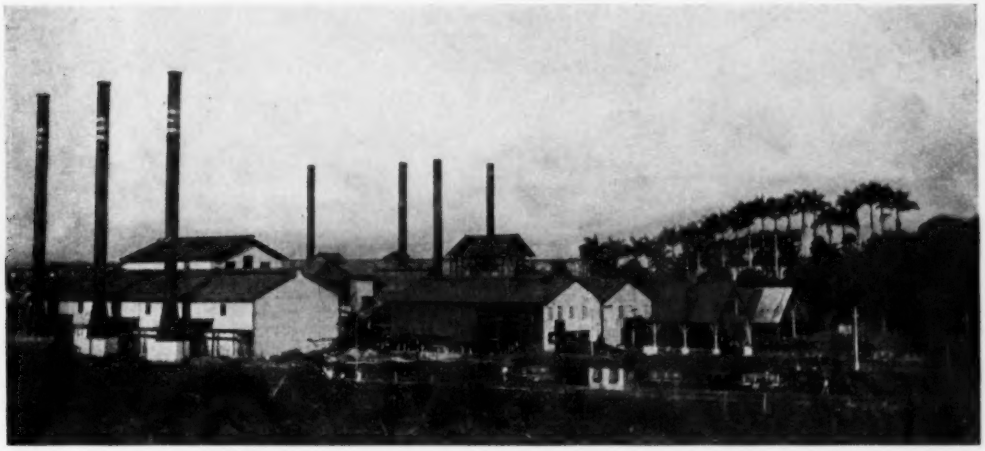

FIGURE 5.—A portion of a modern sugar factory, Trinidad, capable of manufacturing over 30,000 tons of sugar in a season of about 100 crushing days. Central factories represent a heavy capital investment.

TRINIDAD

The main features of Trinidad have already been described in ECONOMIC GEOGRAPHY.* The cane belt lies along the western coast, the northern section in the Caroni Plain, the central focussed around the town of Couva, and the southern in the undulating Naparima District, (Figure 5). The rainfall averages about 65 inches per annum. For many years the canes have suffered severely from "froghopper blight." This damage has become so dominating a factor that it has necessitated and accelerated agricultural improvements. Yields are low, averaging 18 to 20 tons per acre on estates, but special stress is now being laid upon pen and

* Three articles on Trinidad have already appeared in ECONOMIC GEOGRAPHY: "Geographic Factors in the Trinidad Coconut Industry" by Preston E. James, January, 1926 issue; "A Geographic Reconnaissance of Trinidad" by Preston E. James, January, 1927, issue; and "Economic Survey of the Cacao Industry of Trinidad, British West Indies" by the author, April, 1927, issue.

artificial manuring, thorough cultivation, good drainage, and the use of leguminous plants to restore and maintain soil fertility. On the plains, animal, and steam cable implements have long been utilized, but in the Naparima District cultivation had to be performed almost entirely by hand labor until the recent introduction of powerful caterpillar tractors. The record 1928 crop of 80,000 tons was manufactured by 13 factories, to which one contributed nearly 31,000 tons, and four of the remaining factories over 35,000 tons, or, together more than 81 per cent. It is possible that within the next generation nearly the whole of the island crop will be produced by two factories. Two-fifths of the cane supply is grown by cane farmers who possess no financial stake in the factories but sell their cane on the basis of a sliding scale which varies with the price of sugar. East Indians, formerly introduced under a system of indentured immigration, now constitute one-third of the total population. The wide diversity of agricultural wealth, the flourishing oil and asphalt industries, and the need for more intensive cultivation is rendering the labour situation difficult and places a premium upon labour-saving devices.

FIGURE 6.—Cane cutters and loaders, Antigua. The cane carts are drawn by mules or oxen. (Courtesy of Imperial Institute.)

PESTS AND DISEASES [27]

In addition to the local factors described, mention should be made of the more important pests and diseases which cause damage varying in incidence with geographical position, seasonal and cultural conditions.

PESTS

The moth borer (*Diatraea saccharalis*, Fabr.) is a serious pest, severe injury resulting from the tunneling of the larvae in the cane stem. Infestation is diminished by treating planting material with Bordeaux mix-

[27] See Ballou, *Insect Pests of the Lesser Antilles* and *Insect Pests of Sugar Cane in Antigua and St. Kitts;* and Nowell, *Diseases of Crop Plants in the Lesser Antilles.*

ture, and destroying attacked shoots, caterpillars, and eggs. It is attacked by parasitic insects of which the most important is *Trichogramma minutum*.

The larger moth borer (*Castnia licus*, Drury) occurs only in British Guiana and Trinidad, where it is responsible for extensive losses of cane. No satisfactory method of control has been evolved, but the intensity of attack is diminished by catching the moths, flooding the land, collecting the larvae from the cane, and encouraging insectivorous birds.

Froghoppers occur in British Guiana but cause little damage. In Trinidad *Tomaspis saccharina*, Dist., has become so important that a special committee of investigation has been appointed. The damage is caused by the sucking action of the adult insect on the cane leaves and may vary between a slight check in growth and complete destruction of the cane. Hardy and Turner [28] have shown that the intensity of the damage is closely associated with soil conditions and that those soils bearing "blighted" cane are so markedly acidic and so deficient in exchangeable calcium that a material improvement in their lime status appears to be a necessary preliminary to their amelioration.

Other insects have attracted attention but are not of great economic significance; some are merely scavengers and attack only already injured or diseased cane.

DISEASES

The most important fungal disease —known as root disease—results in a stunted condition of the stool, and research has indicated that wet weather, poor soil, defective aeration, and insect injuries, are predisposing factors. Thorough cultivation and rotation of crops form the greatest safeguards.

Mosaic, a virus disease, causes losses under a wide variety of conditions, which may extend to the complete destruction of the crop. Clearing the land of infected material, planting resistant varieties such as *Uba*, and crop rotation, form effective measures of control. Gumming disease, caused by *Bacterium vascularum* (Cobb) E. F. S. occurs in St. Lucia and St. Kitts but can be controlled, particularly by efficient drainage.

Other diseases exist, but, since they are subject to effective control, or only affect canes already damaged, are not sufficiently important to warrant consideration.

THE STE. MADELEINE SUGAR COMPANY, LTD., TRINIDAD

Conditions vary so much from country to country, and even within a country, that the following description of the Ste. Madeleine Sugar Company, situated in the Naparima District (Figure 10) should indicate better the strenuous efforts that are being made to overcome the present depression than a more generalised account.

Much of the area owned by the present company has been under cane cultivation for over a century without rotation of crops, there being at one time about 100 separate factories. With increasing financial distress the private estates were gradually amalgamated by companies into the existing organisation. Of the 24,500 acres owned by the company, 11,500 are under estate

[28] See *Minutes and Proceedings of the Froghopper Committee* and the *Journal of Agricultural Science*, Vol. 1, 1929 (Turner).

cultivation, 6,000 are rented to cane farmers, 5,700 are uncultivated, and the remainder consists of pastures and traces. Cane is also received from a considerable area not owned by the company. The company maintains 80 miles of standard gauge (4 feet, 8½ inches) and 10 miles of 2 feet, 6 inches gauge railway, and a network of roads and traces which are supplemented by the Trinidad Government Railway and the public roads and traces.

The company is endeavouring to reduce its costs of production (Figure 11) by increasing its sugar production, introducing labour-saving devices, and ameliorating soil conditions.

The increased production of sugar (see Table 6) and increased efficiency in machinery have resulted in a considerable reduction in manufacturing costs. While most of this increase in crop is due to the acquisition of additional estates, part is the result of a more intensive use of the land. The estate plants 2,000 to 3,000 acres annually, principally between August and November, during the wet season. The canes are reaped some 15 to 18 months later, and then cut annually as ratoons for a variable period. On account of the laborious process of planting, plant canes, in spite of heavier yields (see Table 7), cost more per ton to produce than ratoons.

FIGURE 7.—A train load of canes proceeding to the factory, Antigua. (Courtesy of Imperial Institute.)

TABLE 6

STE. MADELEINE SUGAR COMPANY'S PRODUCTION

Year	*Crop* (In Tons of Sugar)	*Year*	*Crop* (In Tons of Sugar)
1875.....	2,658	1915.....	17,067
1885.....	4,876	1925.....	23,520
1895.....	9,346	1928.....	30,939
1905 *....	8,711		

* This crop was below the average.

TABLE 7

YIELD OF PLANT AND RATOON CANES

(In Tons per Acre)

Year	*Plants*	*First Ratoons*	*Second Ratoons*	*Third Ratoons*	*Fourth Ratoons*
1925....	24.19	18.58	13.94	13.33	12.05
1926....	28.32	19.60	15.11	13.89	13.75

In selecting varieties special attention is given to their ratooning powers.[29] Many new varieties are

[29] Thus B. 6032, a good plant cane, ratoons badly, and is therefore being discarded. Several canes with excellent records in Java have been introduced but as in that country they are grown only as plant canes, it is doubtful whether they

constantly being tested and, as they demonstrate their superiority, are used to replace the standard canes which, for reasons requiring further investigation, tend, after a time, to deteriorate. D. 625 and B. 156 have given way to B. H. 10 (12) and Uba, the latter possessing exceptional ratooning powers. As excessively ratooned canes are particularly susceptible to froghopper blight and other damage, and tend to increase in cost (Table 8) it has become the policy

TABLE 8

LABOUR COSTS ONLY OF PLANTING, CULTIVATING, REAPING, CARTING, AND LOADING INTO RAILWAY TRUCKS, OF PLANT AND RATOON CANES (IN $ PER TON)

	Labour Costs
Plant	$3.22
Ratoons	
First	1.47
Second	1.53
Third	1.55
Fourth	1.40
Other	1.67

to replant after the second ratoon (Table 9), except in the case of Uba.

TABLE 9

PLANT AND RATOON CANES

Average Acreage Division, During 1925 and 1926

	Acres	*Percentage of Total Area*
Plants reaped	2,622	35.0
First ratoons	2,615	35.0
Second ratoons	1,459	19.3
Third ratoons	395	5.3
Remaining ratoons and standovers	407	5.4
Total	7,498	100.0

The increase in the crop requires additional labour and land. Prior to 1917 labourers, who were indentured to estates for five years, were brought from India, each estate indenting for the number required. Since the cessation of indentured immigration many Indians have been repatriated,[30] while the growth of the sugar and other agricultural industries, the development of the oil and asphalt industries, and the expansion of motor traffic and road work, have intensified the demand for the remaining labour force. The company has endeavoured to induce labour to remain by laying out house lots, and providing facilities for the cultivation of cane by peasants, who are known as cane farmers. New areas have been opened up, labour saving methods and devices introduced, and railway facilities for the delivery of farmers' cane established in areas not owned by the company. Nearly 40 per cent of the cane crushed by the factory is now supplied by farmers. The latest development lies in the Oropouche Valley, an area of some 10,000 acres, where, owing to lack of transport facilities, peasant proprietors have hitherto eked out a miserable existence by growing food crops, particularly rice, and small patches of indifferent "cash" crops. With estate railway facilities this area will provide an increasing quantity of cane without seriously interfering with the existing estate labour supply. Since the farmers possess inadequate capital the company advances money through its Agricultural Credit Societies, which is recovered when payment is made for canes. When, in 1920, sugar reached an unprecedented high level [31] the various sugar estates, in their anxiety to secure additional cane, advanced money recklessly and established purchasing scales in their neighbours' territory. Many farmers received advances from more than one estate. With the slump in the price of sugar, and therefore of cane, in 1921 (see Figure 12), many of

will ratoon well. Cane seedlings have their country of origin indicated by letters and an index number. Thus B., Ba., and B. H., stand for Barbados; D. for Demerara; P. O. J. for Java; S. C. for St. Croix; etc.

[30] 9,111 East Indians were repatriated between 1920 and 1927. The total agricultural population is about 96,000.

[31] On May 19, 1920, 96° sugar, f. o. b. Cuba, sold at £101, 18s., 4d. per ton and fell on December 28, 1921, to £7, 14s., 0d. per ton.

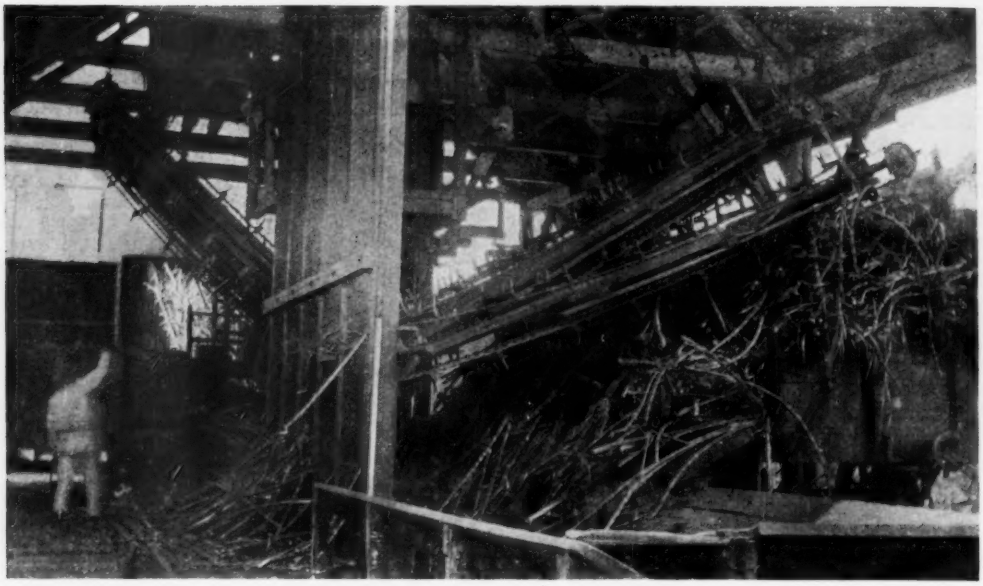

FIGURE 8.—Raking canes mechanically from the railway truck to the cane carrier. A continuous and even flow of cane must be maintained.

these advances became irrecoverable and heavy losses were incurred. Many farmers gave up cultivation and the supply of cane was nearly halved. To avoid wasteful competition, eliminate unnecessary haulage, and facilitate the recovery of advances, the sugar estates agreed, in 1922, to restrict the purchase of cane by each factory within defined areas, and to adopt the same sliding scale of payment. To encourage farmers the company has established an understood, though not guaranteed, minimum price of $2.88 per ton of cane, and has improved the conditions of land tenure. Uba, which ratoons exceptionally well, and smothers weeds by its dense growth, has reduced labour requirements, and the rapid expansion in the Ste. Madeleine Sugar Company's crop during the past five years is largely due to the extended use of this variety. The heavy nature of the soils prevented cattle ploughing and the undulating land prohibited the use of steam cable ploughs, so that preparation for planting had to be accomplished in the wet season with hand labour. The recent introduction of 60 horse-power caterpillar [32] tractors each drawing a four-furrow plough furnished with 28 inch discs, or with chisels or knives, has enabled considerable preparation for planting to take place in the dry season (Table 10). With additional equipment it is anticipated that all land to be replanted will be ploughed or

TABLE 10

WORK DONE BY TRACTORS

Dry Season, 1928 *

Acres	
1,372	Ploughed
570	Graded or round ridged
190	Unploughed fields chiselled
131	Unploughed fields chiselled a second time
136	Chiselled after ploughing
21	Drilled
Miles	
38	Roads and traces graded

* During 1924, the first year, 40 acres only were ploughed. One tractor will plough 4 to 5 acres a day, and, where the contour of the land prevents ploughing, chisel, or knife, 7 acres a day.

[32] The numerous drains and ravines, necessitated by extreme heaviness of the soil, involve the use of caterpillar tracks.

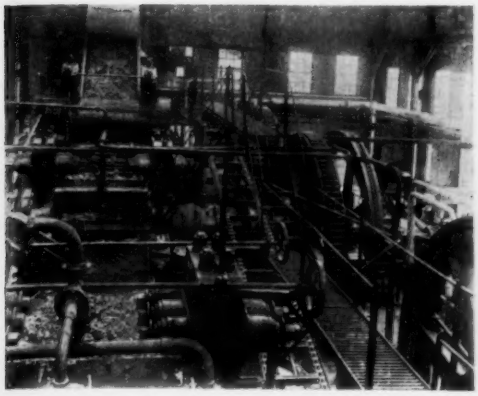

FIGURE 9.—Portion of Gunthorpe's Factory, Antigua, showing cane passing through the mill. (Courtesy of Imperial Institute.)

chiselled,[33] made into beds and formed, and perhaps drilled,[34] by mechanical means thus effecting a very considerable saving in hand labour. The present equipment consists of four 5-ton, one 10-ton, and three 60 horsepower tractors, four Holt and one La Crosse ploughs, two Killifer subsoilers, two Killifer chisels, three road graders (also used for bed formation), one Killifer cultivator, and one harrow (Figure 13).[35]

It has been the practice in the past to allow fields whose fertility showed signs of exhaustion to revert to bush for a number of years. With adequate land this method was very suitable, but it is clear that with increasing crops fuller use will have to be made of the land. The company is attempting to maintain the fertility of the soil for longer periods, to evolve a quicker method of restoring fertility, and to discover varieties of cane tolerant to poor conditions.

Great stress is laid upon the value of pen manure, and it is the practice to apply 20 tons per acre shortly before or after planting. When not working, all animals are kept in covered or open pens containing a layer of cane trash, grass, megass,[36] or other vegetable matter, into which is trampled the animal excreta and urine. Additional material is added until at the end of the dry season the pens are 4 to 5 feet deep in manure. Some 26,000 to 28,000 tons of manure is produced by this method, but as this is insufficient to meet the requirements of plant canes alone, supplementary sources have to be developed. Trials are being made with methods of producing artificial farmyard manure, and with an efficient and economical method, a very considerable expansion of manuring will take place. Indifferent results have been obtained with artificial manures, and elaborate experiments under statistical control are now being prosecuted. The degree of acidity and the lime status of the greater part of the company's soils have recently been shown to be closely correlated with the intensity of froghopper blight. Since the amount of lime required to correct this undesirable acid condition would be large (frequently more than 20 tons per

[33] The ploughs will not throw a furrow uphill so recourse is had to chiselling where no double slope is available.

[34] Drains are normally 25 feet apart and the drills are made, usually 5 feet apart, across the beds to carry off surplus water. Mechanical drilling across the bed would destroy the camber, and the drains. Mechanical drilling along the bed would interfere with drainage. A compromise is therefore being tried, the centre being mechanically drilled along, and the sides hand drilled across, the bed.

[35] The tractors consumed 30,000 gallons of gasolene at 40 cents a gallon, the tax on which amounted to $3,600. It is hoped to introduce tractors using crude oil, which at about 10 cents per gallon would represent a very considerable saving. At present the weight of tractors using crude oil is a severe handicap.

[36] Cutting up the vegetable matter hastens decomposition. Since there is inadequate labour to handle the manure, this is not done during the dry season. Enormous quantities of vegetable matter are necessary, and, to save labour, mechanical grass cutters have been introduced. To save cartage, open pens for bison are established in the fields to be manured, but in Trinidad other animals, e.g., Zebus and mules, are too susceptible to climatic conditions.

acre) the cost involved is regarded as entirely prohibitive.[37] Experiments are nevertheless being made to test the effect of smaller applications on areas where lime deficiency is of lesser magnitude.

Extensive trials are being made with green dressings as a means of soil amelioration. It is now the invariable practice to plant the cane banks with Sword Bean (*Canavalia ensiformis*), Sunn Hemp (*Crotalaria junces*), or Woolly Pyrol (*Phaseolus mungo*), usually an early and a late-maturing variety on alternate banks, which are turned into the soil as the banks are required for moulding (or earthing up) the cane. Fields that have been ploughed, but are not required for planting for periods up to three months, are broadcasted with Sunn Hemp or Woolly Pyrol, to provide a quick cover for keeping down weeds and preventing wash. The cover crop is turned in at cane planting.

To restore the fertility of fields more quickly, it is proposed to plant abandoned fields in *Tephrosia candida*, Pigeon peas (*Cajanus indicus*) [38] or Bengal Beans (*Stizolobium sp.*) [39] but, as ploughing is necessary, this method cannot become general practice until additional equipment is available.

Fortunately Uba is more tolerant than seedlings to poor soils, and this variety has therefore been extended to all soils on which seedling canes could not profitably be cultivated.[40] Unfortunately Uba does not shed its

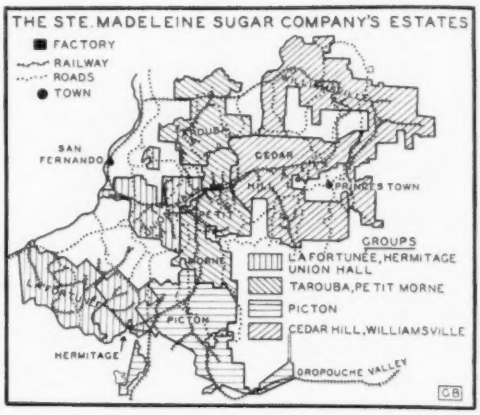

FIGURE 10.—The Ste. Madeleine Sugar Company has a large estate, 24,500 acres, situated in the Naparima District, where every effort is being made to overcome the depression in the sugar market.

trash and has to be burnt before reaping, thus destroying humus and useful (and harmful) parasites.[41] It is of low sucrose and undesirably high fibre content, and is troublesome in the factory. But for these disadvantages the cultivation of Uba would have been extended even more rapidly.

These measures also form part of the comprehensive scheme for froghopper control. Among other methods, recourse is had to insecticides, the most suitable of which is at present Cyanogas (Calcium Cyanide powder) which is effective under favourable conditions, and is dusted on the cane stools immediately the presence of froghopper nymphs is reported.[42] Greater stress is, however, laid on soil amelioration and improved agricultural methods.

While these measures are tending to reduce labour demands, there still remains a shortage during the crop season. Since transport difficulties

[37] Ground limestone delivered to estate costs about $5 per ton. Land can be purchased for $25 to $50 an acre.

[38] Pigeon peas are a popular local food and suffer from praedial larceny.

[39] Bengal Beans provide forage and beans suitable for stock.

[40] This should be borne in mind in comparing yields and costs of Uba and seedlings.

[41] This may account for the increasing prevalence of the moth borers.

[42] The cost of Cyanogas and its application average about $6 per acre.

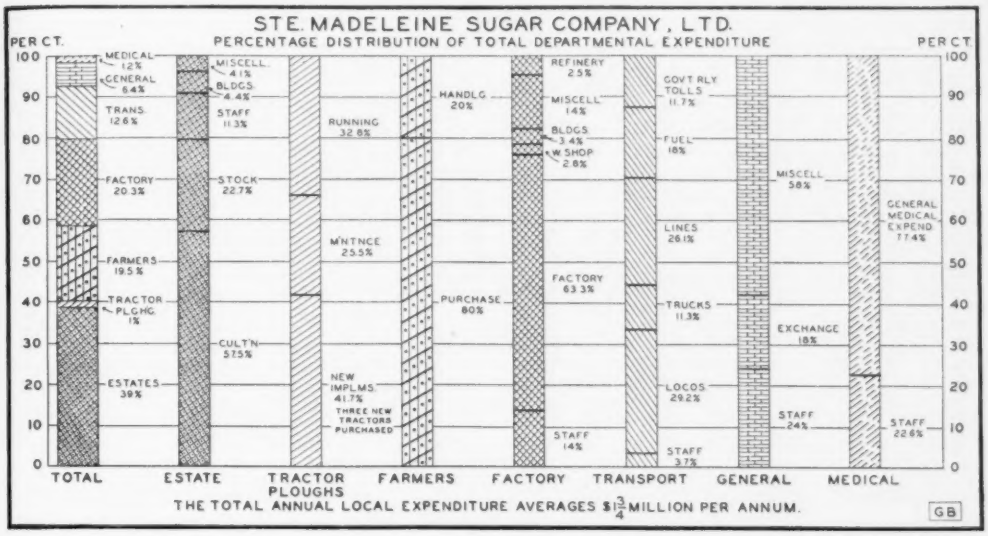

FIGURE 11.—The costs of production of sugar by the Ste. Madeleine Sugar Company are graphically presented by this chart.

limit the crop to about 100 days [43] during the dry season, which lasts from about the end of January to the beginning of June, all other considerations have to be subordinated to the daily delivery to 2,500 to 3,000 tons of cane to the factory. The two mills work day and night, except when out of cane, stopping only from Saturday afternoon to Sunday afternoon to effect the necessary cleaning, repairs, and adjustments. Factory costs increase rapidly with diminished deliveries of cane (Figure 14). As 44 per cent of the 5,000 to 6,000 farmers produce less than 5 tons, and 80 per cent less than 20 tons, per annum, evenness of supply to the factory is extremely difficult to maintain. At the beginning of the season it is impossible to ascertain whether the farmers' canes are ripe and many farm areas are inaccessible until the dry season is well advanced. To surmount this difficulty, the company during recent years has adopted the practice of supplementing the estate animal transport by hiring farmers' carts. As the season advances and the farmers' canes become ripe, and transport easier, the farmers use their carts for their own canes (see Figures 15 and 16).

In addition to the difficulties experienced in regulating the daily supply, ensuring a good quality, avoiding loss in the weighing and transit of cane, and recovering advances, small farmers do not regularly replant a portion of their land. Since their responsibilities are small, they can, with little loss, give up cane growing during a depression and so cause wide variations in annual supply (see Table 11). Badly cultivated patches of cane constitute a reservoir of diseases and pests. To encourage larger farmers, the company offers better terms of payment. These contracting farmers, who now number 31, supplied nearly 30,000 tons of cane in 1928. If each farmer averaged 50 tons of cane per annum,

[43] In South Africa the crop season extends over 7 or 8 months. Hence in Trinidad a factory must be twice the size to deal with the same crop. The cost of a factory in Trinidad is about £20 to £25 for every ton of sugar produced.

TABLE 11

TRINIDAD CANE FARMING AND SUGAR CROP RETURNS

Period	Island Sugar Produced (Tons)	Island Tons Crushed Estate	Island Tons Crushed Farmers	Island Cane Farmers East Indian	Island Cane Farmers West Indian	Ste. Madeleine Sugar Company Sugar Produced (Tons)	Ste. Madeleine Sugar Company Tons Crushed Estate	Ste. Madeleine Sugar Company Tons Crushed Farmers	Ste. Madeleine Sugar Company Price per Ton of Cane	Ste. Madeleine Sugar Company Cane Farmers East Indian	Ste. Madeleine Sugar Company Cane Farmers West Indian
1898–1902	56,287	292,515	134,651	3,261	4,174	.....	99,653	21,226	....	653	812
1903–1907	50,060	347,711	178,192	5,439	5,162	13,461	90,730	41,662	....	1,587	1,172
1908–1912	48,302	393,805	157,590	6,409	5,839	13,153	120,274	35,612	....	1,872	1,233
1913–1917	58,365	397,215	282,404	9,933	7,008	17,606	124,875	56,692	....	3,063	1,400
1918	45,256	252,783	266,144	12,158	8,244	16,643	95,442	80,388	3.84	4,712	2,332
1919	47,850	275,451	270,324	12,370	8,568	16,482	95,570	72,551	4.74	4,322	2,292
1920	58,416	319,421	344,226	14,536	10,824	17,510	93,494	86,344	8.40	4,393	2,778
1921	54,933	286,974	389,399	15,046	11,379	17,740	84,232	106,367	4.84	5,132	3,643
1922	59,948	340,358	355,364	12,605	8,745	17,880	76,334	95,551	2.57	4,072	2,651
1923	41,619	253,211	186,445	9,670	6,830	13,732	74,891	53,938	4.90	3,077	1,952
1924	52,045	324,361	237,298	9,952	7,116	17,203	109,336	59,792	4.52	2,965	1,835
1925	69,629	395,105	327,614	11,508	7,966	23,520	141,825	83,045	2.88	3,455	2,188
1926	73,561	384,002	358,879	13,492	9,447	29,365	162,358	111,316	2.88	3,862	2,822
1927	51,982	330,391	286,700	11,858	7,527	19,434	134,940	78,135	3.45	3,390	1,814
1928	81,551	449,634	375,162	13,224	7,444	30,939	176,691	113,020	2.97	4,712	2,174

the company's cane farmers could be reduced to 1,500 who might, through their Agricultural Credit Societies, be coöperatively organised for the delivery of cane.

The estate traces are mere earth tracks which become impassable during wet weather.[44] The company now employs grading machines [45] that

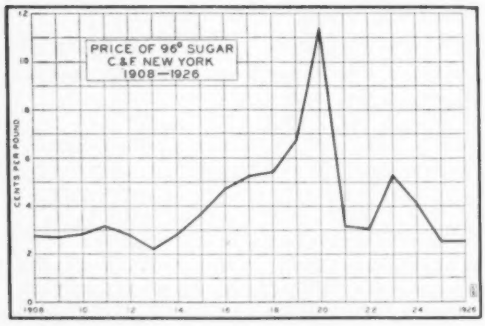

FIGURE 12.—Note the rapid rise in price during the war, followed by the post-war boom when sugar rose to an exceptionally high level. The sudden fall in 1921 brought disaster to many sugar producers, and the industry is still attempting to adjust itself to the new level of prices, which approximates to that of the pre-war period though costs of labour and materials are still high.

give a camber which helps to drain the traces and maintain the surface.

[44] In the exceptionally wet "dry" season of 1927 no less than 30,000 tons of cane remained unreaped owing to the impassable condition of the traces.

[45] As mentioned above these machines have proved very effective in round-ridging cane beds. Thirty-eight miles were dealt with in 1928.

For carting, and providing manure, the company maintains over 2,000 head of stock (Table 12). Among

TABLE 12

UNITS OF LIVESTOCK

June 30, 1926

Horses	78
Mules	580
Oxen	322
Cows	422
Calves	351
Steers	138
Heifers	162
Bulls	36
Others	89
Total	2,178

mules 35 per cent of the available working days were lost for various reasons. Of the days worked less than 30 per cent were utilised for carting cane (Table 13). Animals

TABLE 13

DISTRIBUTION OF MULE AND OXEN UNITS, 1925–1926

	Mule Units Percentage Distribution	Oxen Units Percentage Distribution
Lost	35.4	54.6
Implemental tillage	1.4	1.9
Working derricks	2.4	....
Carting canes	17.9	5.7
Carting forage	12.0	13.0
Carting bedding	10.1	14.9
Carting manure	7.3	6.7
Miscellaneous cartage, etc.	13.5	3.2
Total possible units *.	164,000	96,500

* Calculated on the basis of 5 days per week for 50 weeks =250 days per annum.

are therefore expensive as a means of haulage. Experiments are being

FIGURE 13.—A tractor drawn plough preparing land for planting. Note the high bush. (Courtesy of Ste. Madeleine Sugar Company.)

made with tractors, the main difficulty being to find a suitable type of cane cart. It is anticipated that since each tractor will haul a fleet of carts, and cartage will be less dependent upon weather conditions, a considerable amount of labour will be freed for other urgent requirements.[46] But for the difficulty of securing an adequate supply of pen manure, this would enable many head of cattle and mules to be dispensed with. To supplement the synthetic methods previously mentioned, the company has centralised its dairy cattle, and, with expansion, it is anticipated that the sale of milk and milk products [47] will cover all the dairy expenses and thus a considerable quantity of manure will be supplied free of cost.

The company, like all other cane sugar producers, is on the look-out for a cane harvester [48] that will not only cut, but also top, the cane mechanically.

[46] Owing to the increasing difficulty of obtaining carters many youths unsuited to the work are employed. The tractors will afford an outlet for the preference for mechanical work shown by West Indians who dislike field work.

[47] In 1927 Trinidad imported condensed milk to the value of £100,495, and milk products, or their substitutes, to the value of £109,365, *C. P. 68, 1928*.

[48] Each cutter averages 2.65 tons per day. Hence an average of more than 1,000 men are required daily merely to reap cane for the factory, and a similar number for carting.

With these measures fully developed, labour will be rendered available (Table 14) for the cultivation of

TABLE 14

PERCENTAGE DIVISION OF ESTATE LABOUR UNITS

Subsoiling	6.5†
Round ridging	3.1†
Draining	5.8
Drilling, planting, and supplying	9.1
Weeding	24.9
Digging Para grass	3.8
Clearing pastures and traces	2.1†
Making and applying manure	13.7
Destroying froghoppers	4.2
Stripping and cutting canes	7.5
Heading, picking and loading canes, and working derricks	7.8
Carting canes	7.4†
Other operations	4.1

1,047,396 units=100.0%

† Those operations can either be performed to a large extent, or be substituted, by mechanical methods. This would tend to reduce the number of units employed in other operations, e.g., weeding, which accounts for a very large percentage of the total labour units. It takes approximately 5 men-days to produce, reap, and deliver to the railway trucks, 1 ton of cane.

young plant and ratoon canes which at present have to be neglected during crop. The crop season is the main planting season for the cane farmers, partly because planting material can be obtained very cheaply [49] and partly because the farmer prefers a twelve-month growing period. To relieve the crop pressure, the estate provides cheap planting material during the wet season, but little advantage is taken of this facility.

Unfortunately, part of the crop season coincides with the East Indian marriage season, and, since the guests are numerous, particularly in times of prosperity, temporary dislocation of estate work sometimes results. The rice planting and reaping seasons, and the competition of cane farmers at certain periods of the year, also interfere with estate routine, though on account of the higher pressure of work any interference during the crop season is more serious.

Labour-saving devices have re-

[49] The top joints of the cane only are used during the dry season because they give a better "spring" and are useless for sugar production.

duced the factory labour demands to such small relative dimensions that although the numbers fluctuate greatly (Figure 17) they have little effect on the general labour situation. Owing to the seasonal variation in employment, some difficulty is experienced in retaining suitably qualified mechanics.

A problem of great importance is the profitable disposal of factory by-products, particularly molasses and megass. At one time a rum distillery played an important part in the economy of a cane-sugar factory, but taxation and "prohibition" have rendered returns from this source negligible. The profitable use of molasses for power alcohol, cattle food, and fertilizer, is being investigated. Megass is used primarily as fuel, and not only meets the normal requirements of a modern factory, but also produces a large surplus. Attempts are being made to utilize it profitably as fibre board or paper pulp.

Lack of deep water facilities at Port of Spain and the additional handling necessitated by lighterage increase the cost of exporting sugar. A small tax is imposed upon sugar exports to meet the cost of repatriating East Indians who have served a term of indenture.

This brief and superficial description does not pretend to detail all the problems of all cane sugar producers, or even those of Trinidad. Some of the differences in other parts of Trinidad have already been noted, while many more might be enumerated. In the Caroni Plain, for example, small scale experiments indicate that irrigation might enable conditions to be produced artificially which would diminish froghopper blight and reduce costs of production.

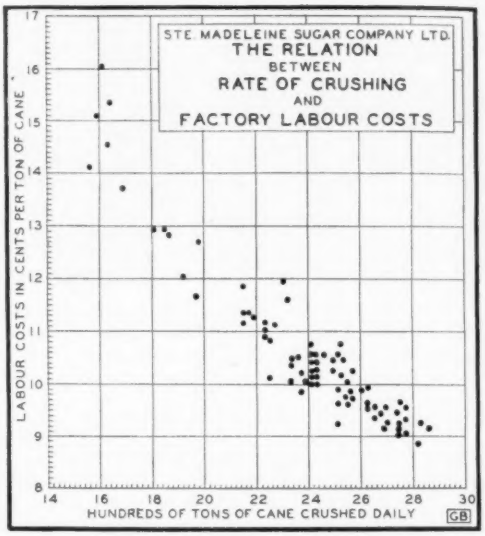

FIGURE 14.—The above diagram indicates that as the quantity of cane crushed increases, factory labour expenses decrease. Saturdays and Sundays, when crushing is not continued throughout the 24 hours, have been omitted. Oil fuel has been omitted from costs since its consumption is largely independent of the rate of crushing. The following table shows some of the coefficients of correlation obtained between rates of crushing and factory running costs. Each result is significant.

Year	*Coefficient of Correlation*	*Pairs of Variables*
1920.....	−0.87	90
1921.....	−0.88	90
1924.....	−0.89	78
1925.....	−0.91	83

The political future of sugar is so obscure that it is doubtful whether the necessary capital would be forthcoming. Every estate has its own peculiar problems, but it is hoped that the above account has served its purpose of indicating the manner in which the present situation is being faced.

THE COLONIES IN RELATION TO THE WORLD'S SUGAR INDUSTRY

Attempts to compare the efficiency of sugar production in various countries are apt to be extremely misleading since conditions differ so fundamentally. The fact that yields of cane in Java and the Hawaiian

Islands average more than 45 short tons per acre, whereas in Queensland, Mauritius, the Philippines, South Africa, and other areas, the average production is less than 20 short tons per acre, does not necessarily indicate inefficiency in the latter countries. That the high yields of Java and the Hawaiian Islands are due principally to irrigation is illustrated by the fact that the yields per acre on estates in the island of Hawaii dependent upon rainfall averaged only 55 per cent of those on irrigated estates in the islands of Oahu and Maui, during the period 1907 to 1921.[50] Even in comparing Java and Hawaii several important differences should be noted. In the former country, plant canes only, maturing in 11 to 15 months, are grown, and cane is rotated with food crops, particularly rice. In Hawaii the growing period is 18 to 24 months and ratooning is practised. The yield per acre during a given time is, therefore, much higher in Java. In Mauritius the average yield per acre is considerably reduced by the fact that half the cane area is in the hands of Indians, whose primitive methods yield only 14½ short tons per acre. The virgin soil of Cuba tends to increase, and the practice of long ratooning to decrease, yields per acre.

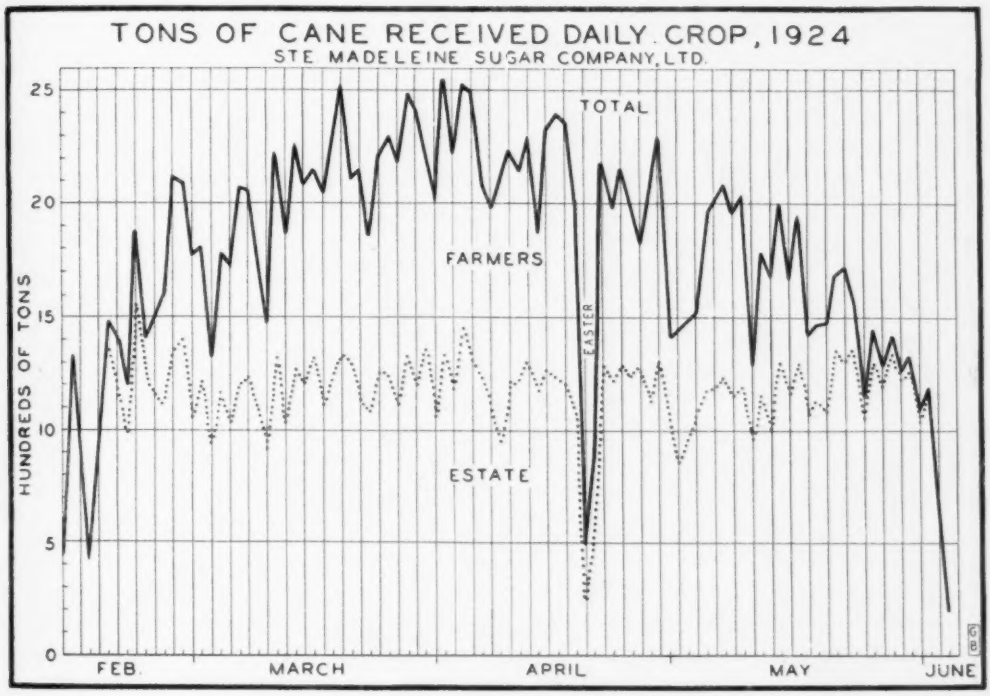

FIGURE 15.—Apart from small daily fluctuations the delivery of estate cane remains relatively uniform. The supply of farmers' cane varies considerably.

Nor do costs of production afford us a reliable criterion of efficiency since rates of wages and labour efficiency vary so widely. In Java, with a population exceeding 35 millions, and an area of less than 50,000

[50] See *Report of the Experimental Station*, H. S. P. A., 1922. In Java more than 90 per cent, and in the Hawaiian Islands more than 50 per cent, of the area under sugar cane is irrigated.

square miles, the daily wage for unskilled male labourers is 20 cents. In Hawaii, with labourers recruited from 18 countries, the daily wage is about $1.50. Other average rates include Queensland $4.08, Cuba $1.20, Mauritius 84 cents, Natal 64 cents, the Philippines 36 cents, and Trinidad 45 cents.

failure in others to attain them does not necessarily indicate inefficiency.

Since the development and prosperity of each country is largely dependent upon its ability to compete in world markets we may usefully study comparative costs of production. In Table 15 an attempt

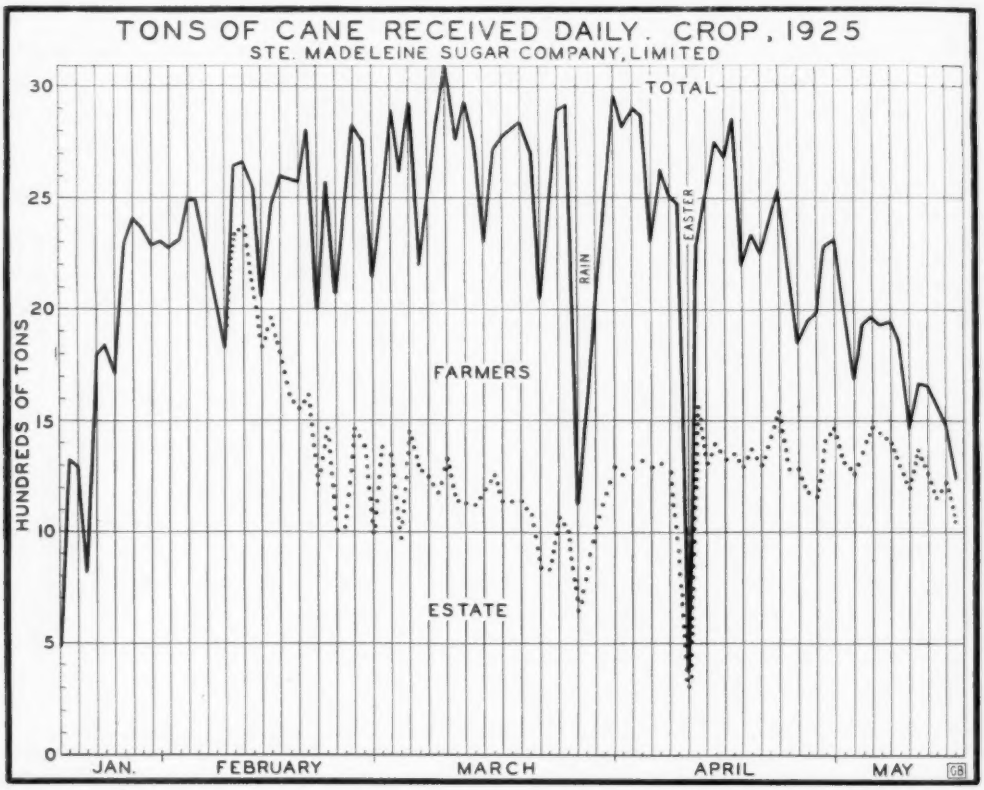

FIGURE 16.—The delivery of estate cane during the early period of the crop has been increased by hiring farmers' carts. The delivery of farmers' cane exhibits an irregularity similar to that for 1924. The aim of the estate is to reach the maximum capacity of the factory as early in the season as possible and to maintain that delivery throughout the season.

Climatic and soil conditions, the length of the crop season, the type of sugar manufactured, local topography, the proportion of cane purchased, land tenure and values, and many other variable factors introduce innumerable complications into comparative tests of efficiency. While the favourable peculiarities of certain countries indicate desirable goals,

TABLE 15

COST OF PRODUCTION OF ONE TON (2,000 LBS.) OF RAW SUGAR

Java	$49
Cuba	50
Trinidad	55
Hawaii	68
South Africa	87
Queensland	121

has been made to reduce the costs of production to the same basis.[51]

[51] The figure for Trinidad has been calculated from the books of the Ste. Madeleine Sugar Com-

These figures should be regarded as only approximately correct and subject to considerable yearly variation. One may, however, legitimately draw the conclusion that Queensland, South Africa, and Hawaii can compete neither in the world, nor in their internal, markets without heavy subsidies or protection.[52] The difference in cost between Java, Cuba, and Trinidad is relatively small. Java's sugar is normally marketed in the Far East, and only sporadically competes in the markets to which the British West Indies and British Guiana send their sugar.

Since the increased world production of sugar has depressed prices to an unprofitable level, one might expect those countries with the highest costs of production to be in dire straits. Such, however, is not the case, and, for this reason, one must make a cursory survey of the principal markets.

The United States and the United Kingdom are the principal consuming countries whose requirements are only partially met by internal production. The United States' consumption averages nearly 6 million short tons of which her internal cane industry supplies 2 per cent, her beet industry 16 per cent, and her insular possessions—Hawaii, Porto Rico, the Philippines, and the Virgin Islands—25 per cent, all of which is admitted duty free, the equivalent of a protection of $44 per short ton. Hence Hawaii, in spite of her high cost of production, is guaranteed not only a ready market but also prosperity. Practically the whole of the remaining 3¼ million short tons is supplied by Cuba, which enjoys a preference of 20 per cent in duty, equivalent to $8.80 per short ton, which, with her low cost of production, guarantees a market but not prosperity. Cuba, with her production of about 5 million short tons, is therefore compelled to find other markets for about 1¾ million short tons. The Continental beet industry, protected in its internal markets, produces more than 1 million short tons in excess of its requirements.

Excluding India which produces, and consumes more than, 3 million short tons of low-grade sugar, British production amounts to about 1½ million short tons, and consumption to 3 million short tons. Nearly half this production is located in Queensland and South Africa,[53] where the internal protection is such that it not only guarantees prosperity, and thus encourages expansion, but also enables sugar to be exported at prices far below the cost of production. Since these Dominions enjoy Imperial Preference most of the surplus is exported to the United Kingdom (Table 16).

TABLE 16

IMPORTS OF AUSTRALIAN AND SOUTH AFRICAN SUGAR INTO THE UNITED KINGDOM

(In 1,000's tons)

From	*1914*	*1920*	*1924*	*1925*
Australia	9	1	44	88
South Africa	..	13	8	36
Total	9	14	52	124

The beet sugar industry in the United Kingdom, stimulated by heavy bounties (Table 17) has rapidly risen to a production exceeding 200,000 tons, all of which finds a lucrative market in the United King-

pany for 1925 and 1926. The remaining figures are taken from: Maxwell: *Economic Aspects of Cane Sugar Production;* Norman Rodger. Taxes have been omitted. A price of $68 per ton (2,000 lbs.) of sugar, f. o. b. Port of Spain, should enable an estate in Trinidad to realize 10 per cent on its capital.

[52] The import duty on cane sugar into Australia is equivalent to $40.56 per short ton, and on sugar, not otherwise specified, $60.84.

[53] Australia approximately ½ million tons, and Natal ¼ million tons.

TABLE 17

BEET SUGAR INDUSTRY OF THE UNITED KINGDOM

Amounts Paid in Subsidies *

Period	*Amount* (In £'s)
1924–1925	492,040
1925–1926	1,066,059
1926–1927	3,225,858
1927–1928	4,309,259
1928–1929	3,250,000 (estimated)

* *West India Committee Circular*, 1928, page 317.

dom. Most of the balance of British sugar is produced in the Crown Colonies, Mauritius, Fiji, the British West Indies and British Guiana, the bulk of which has to be exported. These Colonies, in common with all other Empire producers, enjoy a preference in the United Kingdom equivalent to about $16 per short ton, but share none of the additional advantages afforded to the Dominions and Home producers.

The United Kingdom consumes about 1¾ million short tons of sugar per annum. Before the war 66 per cent of her supply came from Europe, Germany alone contributing 35 per cent.[54] In 1927, 70 per cent of her imports came from foreign countries, Cuba and Europe being the principal sources. Canada, by a reciprocal treaty, affords the British West Indies and British Guiana a preference in excess of that afforded by the United Kingdom, though the benefits to the producers approximate the same. The exports of the British West Indies and British Guiana are, therefore, divided between the United Kingdom and Canada, the latter country taking an annual average of 173,000 short tons during 1923–1927.[55]

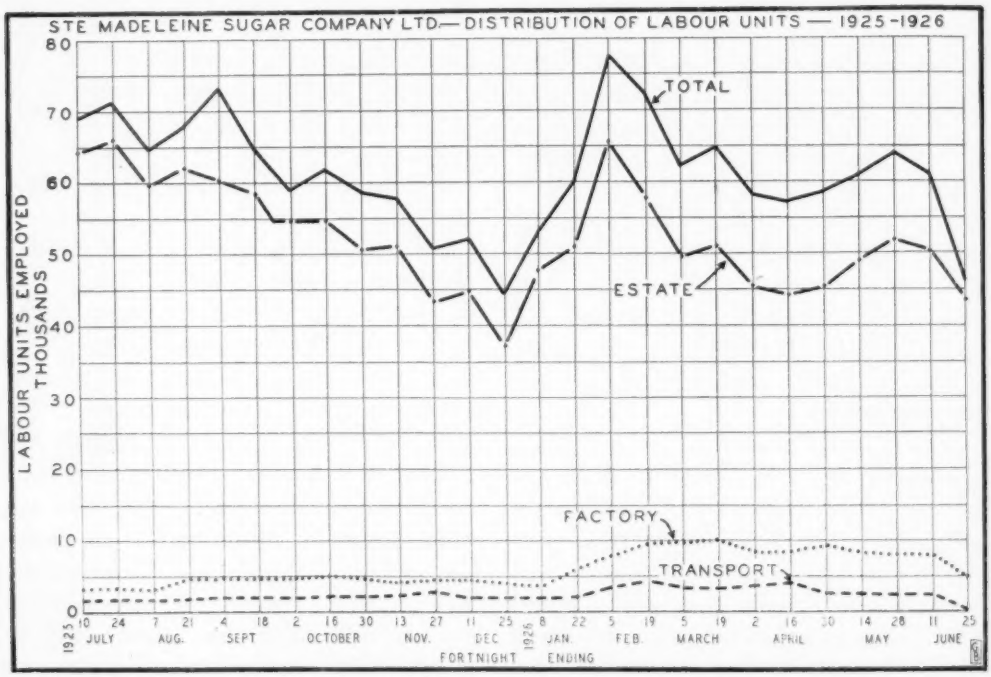

FIGURE 17.—The slight difference in the diagram between the total, and the aggregate units employed on estates, in the factory, and in transport, is represented by the numbers employed in handling shipments of sugar. During February–May, the crop season, every available unit of labour is employed. The peak in the early part of February is partly due to the employment of farmers for carting. During the remainder of the crop they are principally engaged in dealing with their own canes. Planting accounts largely for the heavy employment during August and September.

[54] Average for the three years, 1911–1913.

[55] Figures kindly supplied by Canadian Trade Commissioner.

TABLE 18
EMPIRE PERCENTAGES OF UNITED KINGDOM SUGAR IMPORTS

Year	*Percentages*
1880	24
1914	9
1924	16
1927	30

The preference has stimulated the imports of Empire-produced sugar. Although these modest preferences guarantee a market to the British West Indies and British Guiana, and are vitally important, they by no means guarantee prosperity, and we have the anomalous position that, although the Colonies produce by far the cheapest sugar within the British Empire, they are the least prosperous.[56] With all sugar tariffs and bounties swept away, they alone among British Empire sugar producers would survive;[57] yet, under existing conditions, they are nearest to extinction. Sugar production in the British Colonies is more a political gamble than an economic proposition.

SUMMARY

1. Sugar production has always been the subject of considerable political interference which, until the beginning of the nineteenth century, was calculated to foster and protect the British West Indies and British Guiana.

2. Throughout the nineteenth century the Colonies were the subject of political contempt, and the state-aided competition of the beet sugar industry brought the Colonial cane sugar industry to the verge of extinction.

3. Alternative crops were introduced, some islands gave up cane cultivation, cane areas shrunk and were consolidated, private estates gave way to companies, factories were centralised, and yet the depression continued.

4. The West India Royal Commission, followed by the abolition of the bounty system, and the formation of the Imperial Department of Agriculture for the West Indies, marks a new era in Imperial politics. The interest in, and interference with, the Colonies by the Imperial Government has saved the Colonial sugar industry, but has not restored prosperity.

5. Each island has its own peculiarities, the salient characteristics of which have been briefly described, together with the influence of the major pests and diseases.

6. In order to illustrate the methods of development, a more detailed examination is made of a large sugar estate. The focus of research is shifting from the factory to the field and transport sections.

7. A survey of the world's sugar industry reveals the British West Indies and British Guiana in a favourable light; yet, in spite of the fact that they produce the cheapest sugar within the Empire, they remain the least prosperous. Only improved political treatment, or increased prices, both of which appear remote, and are outside the control of the producer, can restore prosperity to the sugar industry of the British West Indies and British Guiana.

[56] Although the cases are not parallel, it is of interest to note that if the British West Indies and British Guiana enjoyed the same bounty as the United Kingdom beet industry, nearly £6,000,000 would be available for distribution among the producers. The Ste. Madeleine Sugar Company, lost, on an average, $3 on every ton of sugar produced between 1921 and 1927.

[57] As before, India is excluded. Only 10 per cent of the world sugar production is unprotected, 8 per cent being produced in Java alone.

(NOTE.—The writer desires to acknowledge his indebtedness to all who have assisted him in the compilation of this description, particularly the late G. C. Skinner, Esq., General Manager, and G. A. Jones, Esq., Acting General Manager, of the Ste. Madeleine Sugar Company; his colleagues at the Imperial College of Tropical Agriculture; and Sir Francis Watts.)

IRON AND STEEL INDUSTRY OF THE MIDDLESBROUGH DISTRICT

John W. Frey

Geographer, University of Wisconsin

THE iron and steel industry of the Middlesbrough district, or Northeast Coast, as it is called by the British iron and steel manufacturers, is in its origin, setting, and function different from that of all the other iron and steel districts of the United Kingdom.

The iron industry of early England was influenced largely by wood and by water power resources—its importance was determined by the extent to which these resources could be utilized, and its history was directly related to the shifts in supply of these commodities. As long as the demand for iron was not great and there was no imminent danger of wood shortage, the industry of such regions as the Weald and the Forest of Dean prospered. But when the naval ambitions of Queen Elizabeth and her successors developed, and when the towns began to see the possibility of fuel shortage, conservation of the forest became an urgent problem and the iron industry in consequence suffered. Certain regions, such as the Weald, were at first excepted, but gradually law forced all English iron makers not to rely upon wood from virgin forests, or on the by-product of woods maintained for other purposes, but to base their supply upon coppices specifically preserved for the iron works. It must be obvious that no great industry could have developed upon cultivated wood. Later, in competition with coal and coke regions, regions such as the Weald, which had no coal, were forced out of existence.

Most of the modern iron and steel centers of the United Kingdom were located primarily by coal, and secondarily by the iron ore of the associated coal measures. In many instances the works were a long distance from the iron mines. Water power, while important in the location of the first plants of the coal period of smelting, as at Sheffield, was not a dominating factor after 1775, for the furnace blowing-engine superseded it.

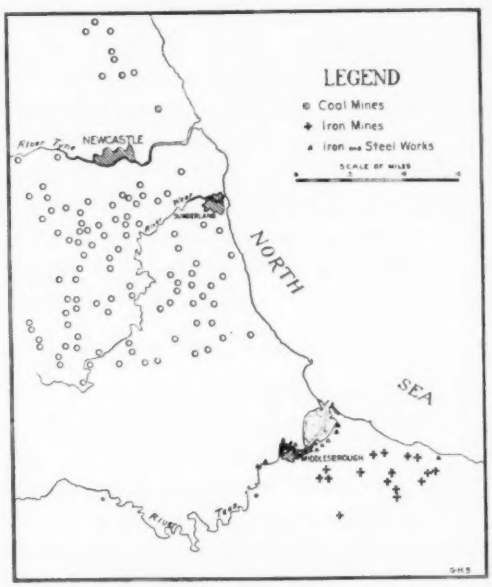

FIGURE 1.—Northern Cleveland and Southern Durham. Note that the coal field in the drainage basin of the Wear is sharply separated from the iron and steel district of Cleveland.

If coal was the dominating factor in the location of the modern iron indus-

FIGURE 2.—The Clarence Iron Works, Middlesbrough. This plant is located on the north bank of the River Tees. Stock piles of foreign ore are to be seen back of Clarence. (Courtesy of Dorman and Long, Ltd.)

try there should be an iron industry for every major coal field, and this in general is true, but in the Northeast of England there is no great iron industry centering on the Durham coal field. In view of the fact that this region produces a superior coal for metallurgical uses, a coal which on an average has less than 6 per cent of ash and 0.6 per cent sulphur, both of which are easily reduced further by washing; it seems peculiar that there furnaces a producer of iron? According to Mr. Bell, who in 1863 read a paper on this subject before the British Association, the Whitehill furnace built in 1745 operated on ironstone gathered in Robin Hood Bay (just south of Whitby). This iron ore was conveyed by water to a point on the Wear near Chesterle Street and carted from that place to the works. Soon after 1800 the Tyne Iron Company obtained ore in a similar way

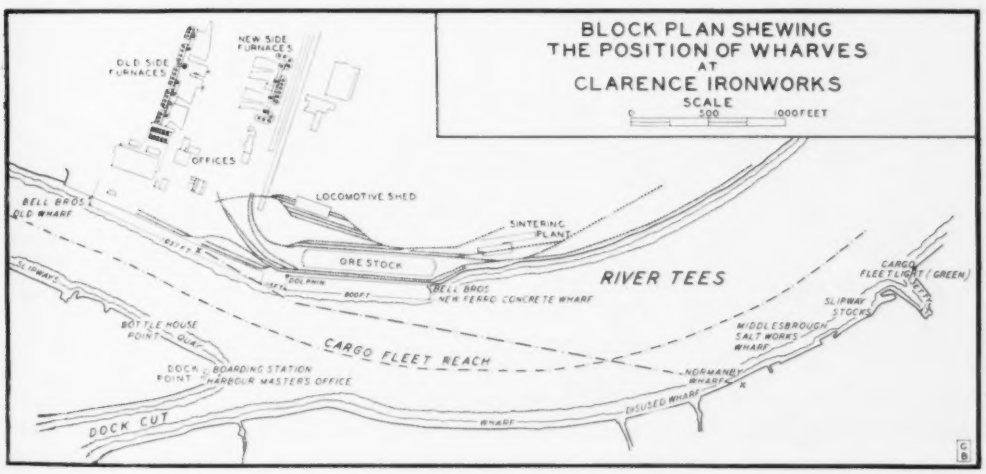

FIGURE 3.—The details of the relation of the Clarence Iron Works to the transportation facilities afforded by the River Tees. (Courtesy of Dorman and Long, Ltd.)

is no blast furnace center on the Tyne. This raises the question: Was the region about New Castle at any time after the introduction of the method of using coal or coke in blast from the beach between Scarborough and Saltburn. This indicates clearly that the coal measures of Durham did not yield iron ore in sufficient quantities for even the blast furnaces of

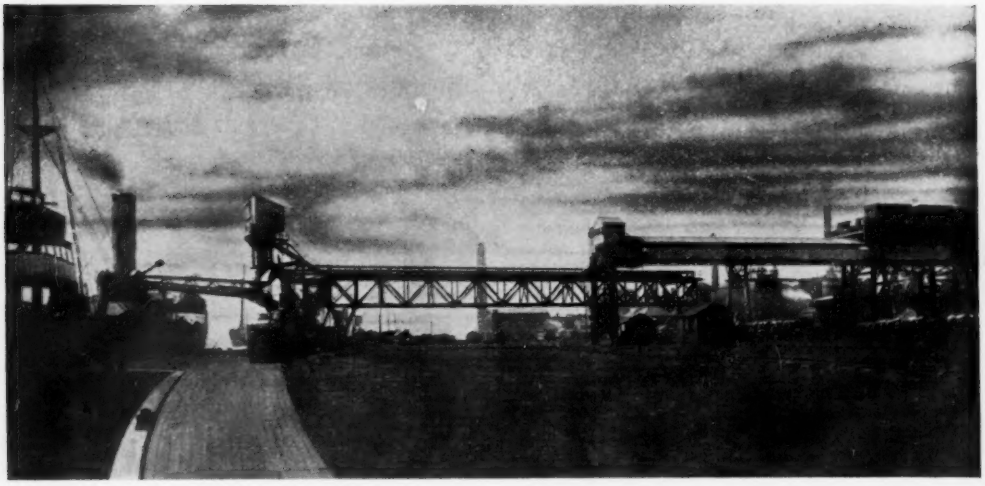

FIGURE 4.—Clarence Coaling Plant, Middlesbrough. Some ships bearing iron ore to Middlesbrough take return cargoes of Durham coal. (Courtesy of Dorman and Long, Ltd.)

that day. It appears that the Tyne Iron Company commenced about 1815 to tear ironstone from its bed at different parts of the coast; but the exposed character of the Yorkshire coast, and the want of shelter, rendered the conveyance of ironstone to New Castle furnaces a task of great difficulty and some danger. Whitby came to be the main source of ore supply for the Tyne region.

At the eve of the development of the Middlesbrough district there were 38 furnaces in Durham operating on iron ore from Whitby. Iron ore from the coal measures, and iron nodules from the mountain ironstone formation, was used in combination with the Whitby ore. The entire make of the furnaces never exceeded 150,000 tons a year. The Tyne industry did not become important be-

FIGURE 5.—The Britannia Steel Works—one of the many plants with an advantageous water frontage on the River Tees. (Courtesy of Dorman and Long, Ltd.)

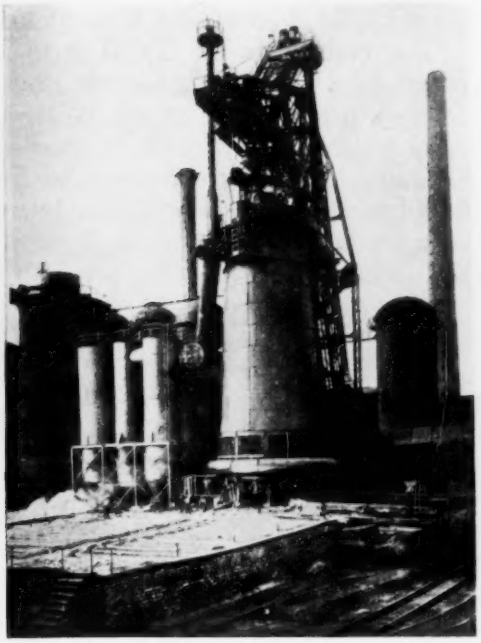

FIGURE 6.—A modern mechanically charged blast furnace in the Middlesbrough district. (Courtesy of Dorman and Long, Ltd.)

cause it could not compete with the Scotch industry, which had the advantage because of the thick and rich black band iron formation which underlay them.

Up to 1850, no thick strata of iron ore had been discovered along or near the Cleveland coast, besides the metal content of that which was known did not exceed 25 per cent. But in 1850, richer and thicker deposits were found along the northern flank of the Cleveland Hills which parallel the Tees River, and the mining, or rather at that date, the quarrying of iron ore began in earnest.

This marks the beginning of the Middlesbrough iron industry. In order to be near the recently discovered ore, Mr. John Vaughan, in the year following the discovery, built the first blast furnace on the virgin soil on the banks of the Tees. Two years later the "Clarence" furnaces were built by Bell Brothers.[1]

Both of these plants were built to take advantage of the Cleveland ironstone. The river at that time was not considered important in its overseas possibilities, for its depth of 3½ feet, at low water, over the bar limited it to inland transportation. Although the industry was not located with direct reference to the coal, better coal than the Durham could not have been found elsewhere in the United Kingdom. And the high quality of the coal taken in connection with enormous quantities easily available and at close range no doubt contributed greatly to the rapid growth of the Middlesbrough district. Today Durham produces 40 per cent of the coke made in the United Kingdom, and this field with

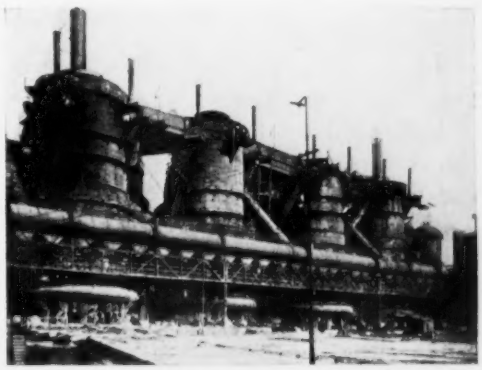

FIGURE 7.—Old style blast furnaces in the Middlesbrough district. A peculiar association of old and new equipment is common to the district. (Courtesy of Dorman and Long, Ltd.)

[1] "The founders of Clarence Works were amongst the first to appreciate the exceptional value of the mineral deposits of Cleveland. Strictly speaking, the Works are not in Middlesbrough, being at Port Clarence, on the opposite side of the river Tees, and, therefore, in the County of Durham. Various causes led to the selection of this position for the erection of the Works. So soon as the discovery of Cleveland ironstone was made, a careful examination of the district was to find an eligible site for the new works. Naturally the essentials were land possessing the mineral and easy access to the river. A royalty was secured from those in-

FIGURE 8.—Modern by-product coke ovens. Note proximity to the river. (Courtesy of Dorman and Long, Ltd.)

the adjoining Yorkshire produce over two-thirds of the total British output. The new industry was also favorably located with respect to limestone, for Wearsdale and East Yorkshire, which produce 41 per cent of the metallurgical limestone used in the United Kingdom, lie nearer Middlesbrough than any other iron-producing center.

That the combination of geographic circumstances was favorable is indicated by the rapid growth of the industry. Twenty years after the furnace was built, there were 130 blast furnaces operating in the district, 86 of them on the Cleveland side of the Tees River, and the industry had come to rank fourth in the United Kingdom, being exceeded by Monmouthshire and South Wales with 188 furnaces; South Staffordshire and East Worcestershire with 165 furnaces, and Scotland with 160; the next below Middlesbrough was Cumberland with only 65.

Although it is hardly possible to say with absolute assurance that the characteristics of the Cleveland iron ore were responsible for the development of the basic open hearth process of steel manufacture, yet the method was in part developed in a Middlesbrough plant; at any rate, the industry was in position to benefit by this process, for the Cleveland ores were phosphoric to the extent of nearly one-half of 1 per cent. Today the entire region has adopted the open hearth process of steel making. The utilization of by-products is well developed, the slag is transformed into fertilizer, road metal, and cement; the flue dust goes through an extraction plant for potash recovery.

The peak of Cleveland iron ore production came in 1883. By that time hematite pig iron was being made in the district. Today out of 126 blast furnaces in operation, 21 use hematite ore imported from Algeria and Spain. This ore is discharged from the ships directly to the blast furnace wharves. This has been made possible by the work of the Tees Conservancy Commission, which for many years has been improving the river. Dredged and confined to its channel by artificial banks, the river is now 20 feet deep at low tide and 37 at high tide. In addition to restricting the channel, no less than 2,800 acres of land have been recovered for industrial purposes. In the hematite industry and in the export trade in iron

terested in the Normanby estate. One of the interested parties in this estate was also interested in the contemplated Hartlepool Railway. It was made a condition of this gentleman's consent to ironstone lease that the new Ironworks should be erected contiguous to this railway, of course, with the object of securing the carriage of the coal from the Durham coal fields to be used in smelting. There were other contributory causes, but this was the main reason for erecting the Works in the County of Durham. The Stockton and Darlington Railway opposed the formation of the new railway successfully, and the founders of Bell Brothers, in coöperation with the owners of the Normanby minerals, sought to obtain independent access to the ironstone. In this effort they were entirely successful, and the Cleveland Railway was the result. By this means the Cleveland ironstone was brought from Normanby to the river side, to Clarence Ironworks. Collieries in Durham were next purchased, and the Works developed quickly at Port Clarence." (*The Iron and Coal Trades Review, October 2, 1908.*)

and steel, the importance of the Tees is hard to overemphasize. The progressive iron masters are convinced that it is a mistake to lay down furnaces and mills in the interior, for inland positions make the industry subject to railway rates which may be discriminatory; besides, such indus-

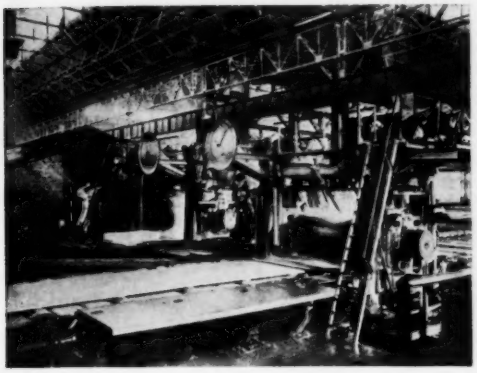

FIGURE 9.—A plate mill in the Redcar plant. This is one of the most modern pieces of equipment in the Middlesbrough district. The electric driving motors are located in the shed to the left. (Courtesy of Dorman and Long, Ltd.)

tries are cut off from cheap sources of overseas ore and billets, and may not have favorable rates to the coast on finished products.

One has only to cite a few examples of railway freight rates to show the value of the tidewater location. For instance, the pre-war rate on billets and blooms from Middlesbrough to London, a distance of 241 miles, was $3.60; while the rate from Middlesbrough to New York or Philadelphia on the same products was $3.00. According to Mr. Stubbs, Secretary of Dorman, Long and Company, the current freight rate from their works on the Tee to their wharf in London is 26 shillings by rail against 14 shillings by water.

Conservation of power and fuel has been another aim of the iron masters. A large proportion of the power used in the district is generated by means of waste heat from the blast furnaces. The entire region is tied together by a coöperative electrical system. Apropos of electrical power, practically all of the machinery, including the enormous cogging mill and the only universal mill in the United Kingdom, in the newest plant in the district—that of Dorman and Long at Redcar—is driven by electricity.

An economy has also been accomplished through the use of gas from the coke ovens for municipal supply. The gas given off in the earlier part of the coking process is sent direct to the city of Middlesbrough. Ordinarily enough gas is produced to supply their demand.

Taking the Middlesbrough district as a whole, it is organized for the economical mass production of pig iron, steel billets, steel plates over 1/8 inch thick, and structural shapes. It is not a region which produces all types of iron and steel products. It produces pig iron to supply the demand of foundries and steel makers of Yorkshire, particularly Sheffield. Likewise most of the billets are supplied to Sheffield, although some are shipped to South Wales. The rolling mills do most of their work for the ship building industry of the Tyne, and to produce an exportable surplus.

Though Middlesbrough is no Pittsburgh, or Gary, in magnitude it ranks high in the British industry. The annual average make of pig iron over the ten years ending in 1914 was 3,539,000 tons, representing 37 per cent of the annual output of the United Kingdom. This average was more than twice that of the nearest competing district. In steel manufacture the position of Middlesbrough is not materially different, for in the British annual production of eight to

ten million tons of steel, the Northeast Coast, Scotland, and South Wales were the regions producing more than one million tons each; Scotland and the Middlesbrough district, each with a production of about two million tons, seasaw for first place—neither one exceeding the other any year by more than several hundred thousand tons—South Wales occupies the third place, while all the others are far below.

THE GRAPE INDUSTRY OF SPAIN AND PORTUGAL

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Geographer, University of Illinois
and
Elizabeth R. Blanchard

IT is difficult for peoples of humid lands to appreciate the priceless boon of the olive and the vine to those who live in regions of summer drought. Providers of meat and drink in lands of little promise, without them, much of the rock-ribbed Mediterranean, must in summer, at least, be abandoned to the desert. At this season one may travel for countless miles over sun-baked arid plateau, over barren, rocky hills and through deep river valleys with little natural vegetation and less water, everywhere the air heavily laden with dust, and in the midst of this desert sea one finds at intervals whole mountain sides molded into huge terraces and covered with green vineyards and groves of olive trees—oases of vegetation upon which the people of nearby villages must depend for their livelihood.

Importance of the Vine in Iberian Agriculture

In the agricultural economy of much of Iberia, as in the Mediterranean region in general, the vine plays a rôle second only perhaps to the olive. Its importance is attested by (1) the large acreage devoted to its culture, (2) its widespread distribution over practically the whole peninsula, (3) the great value of the crop—particularly in the form of its chief end product, wine, (4) the high rank of the latter among the chief export items, and (5) its importance in the daily diet of the peasant populations of both Spain and Portugal.

Extent

The vineyards of these two countries cover over four million acres—an area somewhat larger in extent than that so used in France. Based upon the acreage occupied by the various crops of the peninsula the vine ranks fourth, *i.e.*, after wheat, barley, and the olive. In Portugal alone, where the more abundant rainfall reduces the importance of barley, the grape occupies third place with barley following. For reasons given later the vine acreage of Iberia is increasing very slowly, more slowly in fact than that of any of the other crops mentioned above. The production of grapes, while also increasing, shows a marked fluctuation from year to year in both quantity and quality due to the climatic conditions and the ravages of diseases and pests.

Factors Affecting the Distribution

Though occupying an area some 20 per cent smaller, the vine is far more widely distributed in the peninsula than is the olive. The explanation is to be found in the more exacting climatic requirements of the latter which needs about twice the number of heat units to bring it to maturity. Furthermore, the dormant grapevines are more tolerant of lower winter temperatures than are the

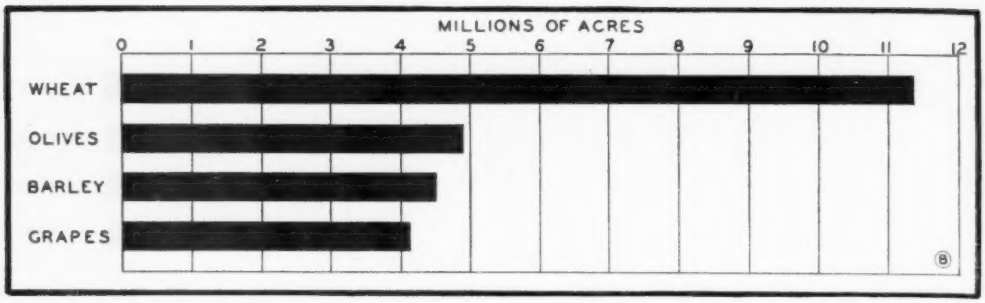

FIGURE 1.—Acreage of principal crops in Iberia in 1924, a reflection of the semi-arid condition characteristic of the larger part of the peninsula.

olive trees. So that while the olive is practically eliminated from northwestern Iberia, the vine is nowhere, in either Spain or Portugal, an entire stranger. This humid northwestern section does not, however, provide the most favorable conditions for vine growth and we find here more scanty distribution than elsewhere. Eastern Spain, inland from the irrigated coastal lowlands, is the principal producing region, with Catalonia and La Mancha usually dividing the leadership.

In Iberia, as elsewhere, "Bacchus loves broad sunny slopes" not only because frosts there occur less frequently, but because on the meseta in particular this location commonly insures cooling winds to temper the intense summer heat which, unmitigated, might impair both the flavor of the fruit and the vigor of the vines. On the other hand, in the raisin region of Campanillas in southern Spain a sort of siroco, known locally as the "terral," often broils both foliage and fruit, destroying the entire season's crop. Winds, too, by driving inland the cold fogs, may be an important factor in the dissemination of fungus diseases to which the grape is highly susceptible.

Of all the agencies of destruction, however, the deadly phylloxera has been the worst. It is today largely responsible for holding in check the increase in vine acreage and its ravages still constitute the most serious handicap of the producer of grapes. In 1924 a report on the condition of Spanish vineyards showed that of the total acreage only about 56 per cent were entirely free of phylloxera. Of the remainder, about two-thirds had been reconstituted, while almost one-third were infected and decadent, though still productive. At its worst this disease, together with unseasonable climatic conditions, reduced whole populations in Andalusia to a state of famine. Entire regions which a half century ago were world-famous vineyards have been completely denuded of the vine and turned into pasture. In the famous sherry wine district it is estimated that the work of the phylloxera has reduced the vineyard area by two-thirds.

The hard smooth surface of the leaves and stems, and the long drought-resistant roots make the vine admirably suited to the dryness of the Spanish summer. Less than 3 per cent of the vineyards are under irrigation.

In some regions contour ditches which are made on the hillside serve both to catch the rain and to prevent gullying. Likewise after the harvest, hollows may be dug about the roots

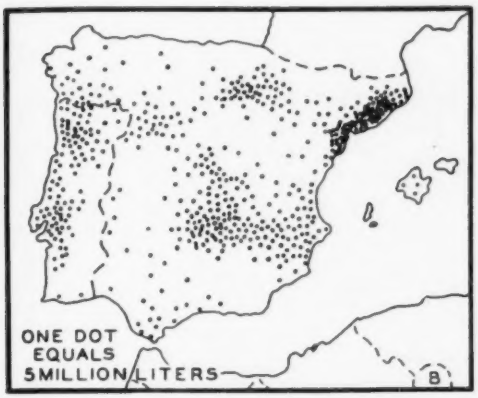

FIGURE 2.—Wine production in Spain and Portugal, 1924. Although the vine is found in all parts of the peninsula, the principal districts of its culture are close to the margin of the meseta, with the single important exception of La Mancha. This province and that of Catalonia are the leading districts.

to serve as tiny reservoirs for catching the winter rainfall. Artificial watering is resorted to only when absolutely indispensable, since grapes that have been under irrigation produce wines which are usually considered inferior both as to flavor and keeping qualities.

UTILIZATION OF GRAPES

In the disposition of the Iberian grape crop there are two all-important facts. The first is that the great bulk of the vintage is destined for the wine press. In Spain, for example, only 6 per cent of the grape crop is normally consumed fresh or made into raisins, while the proportion of Portugal's output so disposed of is considerably smaller than this. The magnitude of the grape-wine production is indicated by a report at a recent Spanish Wine Growers' Congress, where it was stated that the industry in Spain alone represents a capital investment of from $120,000,000 to $150,000,000 and furnishes employment to from three to four million people.

Spain and Portugal rank third and fourth respectively among the wine-producing countries of the world with a domestic consumption correspondingly high, which brings us to the second important fact in the disposition of their grape crop, *i.e.*, that it, like the olive crop, is destined chiefly for the domestic market. In 1924, for example, only one-fifth of the Spanish output of wine was exported. Most of the wine is light, *i.e.*, it possesses a low alcoholic content. Taken with meals, it renders more palatable the peasant's simple diet of bread, beans or peas, soup, and oil. It also provides the large quantity of liquid refreshment required by people in a warm region where much of the drinking water is likely to be unpalatably warm, if not, at the same time, impure. Thus, the annual per capita consumption of wine in Iberia is over twenty gallons, or two-thirds of a barrel for every man, woman, and child.

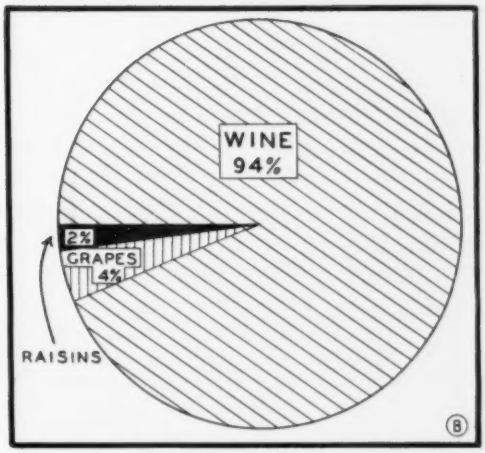

FIGURE 3.—How the 1924 grape crop of Iberia was used. By far the greatest part of the vintage is destined for the wine press and mainly for domestic use. The raisins and fresh grapes are, on the other hand, primarily for export.

Although the proportion of wine exported is small, the total quantity involved is so enormous as to make

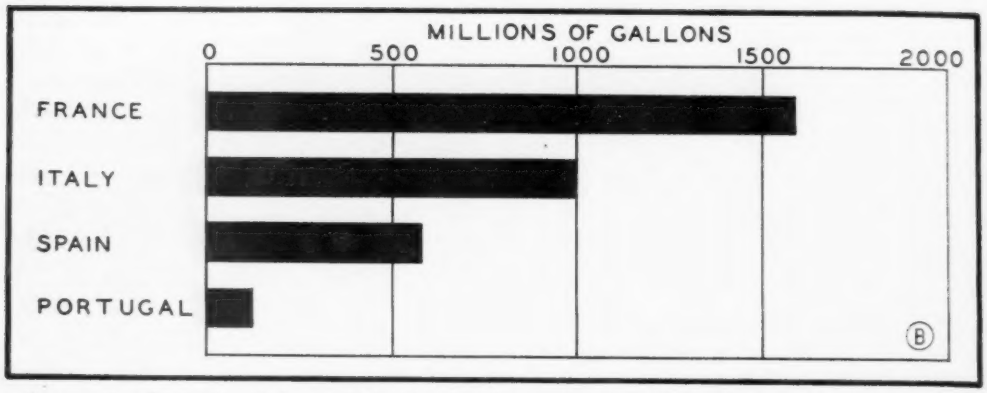

FIGURE 4.—Countries of the world leading in wine production, 1921–1925. Italy produces about twice and France about three times as much as Spain.

its value loom large in foreign trade. In 1924 wine ranked second in value among all Spanish exports, and constituted one-ninth of the total. In Portugal wine leads the export list. France has normally been the best customer for Spanish wines,[1] and their prohibitory tariff imposed in 1920 was a much more severe blow to the wine industry of Spain than was the adoption of prohibition in the United States. With regard to Portugal, the latter measure, though operating indirectly, exercised a marked influence on the wine traffic. Until then France had been, for Portuguese red wines as for those of Spain, a large customer, using these wines to mix with their own. The closing of the United States' market to French wines called forth a maximum import duty on Portuguese wines to "protect" their own. A tariff war followed and the French market remained closed to Portuguese wines until 1925. Further difficulties were encountered with Norway in 1923 on account of the Norwegian prohibition policy. In retaliation the Portuguese levied on cod imported from that country a tariff five times the ordinary maximum for such imports, and obtained thereby a concession authorizing the import into Norway of port and Madeira wines of a specified strength.

Certain regions of both Spain and Portugal have acquired world-wide reputations for especial quality wines, many of which carry the names of their producing regions. Thus there are the "Tarragona" wines or "Spanish port," Malaga wines, sherry from Jerez de la Fonterra near Cadiz, Madeira, from the islands of that name, and, perhaps the most famous of all, the port wines exported from Oporto.

FIGURE 5.—The Alto Douro or port wine district of northern Portugal. Wine, to be legally labeled "port," must be produced within this shaded area and exported via Oporto.

[1] In 1917 the exports of red wine alone from Spain to France reached $22,885,380 out of a total export of this quality of $25,265,388.

FIGURE 6.—A famous port wine plantation on the Douro. Note the outcrop of schist in the left foreground, the owner's mansion in the center, and the railway which follows the narrow valley.

THE PORT WINE DISTRICT

Within the desert reaches of the Upper Douro and its tributaries in northern Portugal flourish the most famous of the world's vineyards—those of the port wine region.

This district, as it is today with its complete monopoly of the port wine industry, represents a series of readjustments. Until the middle of the eighteenth century the chief wine-exporting area lay near the Spanish border, some forty miles north of Oporto. Eventually the superiority of the wines from the Douro region came to be recognized, and with the added attraction of the facilities for transport afforded by the river, the center of the wine industry gradually shifted southward with Oporto rather than Viana as the chief point for shipment. As early as 1756 the government recognized the importance of protecting the name and reputation

FIGURE 7.—A vineyard in the making. Extensive retaining walls, often ten or fifteen feet high, are built of slabs of local schist. Since no mortar is used, almost constant repair is necessary.

of the wines from the Douro and delimited the region whose products could legally be termed "*port*." The boundaries were revised in 1907, as

FIGURE 8.—A village in the port wine district—Freixo de Espana a Cinta—with olive and almond trees in the foreground, and vineyards covering the terraced slopes in the background.

shown in Figure 5, so that today genuine port may be made only in this specified region and shipped only from Oporto. The area of the port wine district as defined by law is about 66,690 acres, or 8.6 per cent of the total wine area of Portugal.

Upon the inhospitable slopes along the streams the vineyards have been laid out with the most laborious and painstaking care. Much of the bed rock of the region consists of tilted strata of a soft brown schist along whose joints and bedding planes the roots of the vines may penetrate to considerable depth in their search for moisture. To provide a "footing" for the vines it has been necessary to terrace the sides of the mountains, and often these terraces are carried to the very summit. For their retaining walls, use is made of the slabs of schist laid without mortar so that continual repairs are needed. Occasionally hillsides are blasted out, and even holes in which the vines may be planted are sometimes cut into the rock.

Since the region is largely enclosed by mountains, wide ranges in temperature are common. In the summer the thermometer often reaches 100° or even 110° in the shade, while in the winter heavy frosts are not unusual.

The sensitiveness of the grape to its environment is illustrated by the variation in the quality of the wine obtained from different parts of even this limited area, the quality varying with the location of the vineyard both vertically and horizontally, as well as with the particular year of the vintage. From the flood plains where the alluvium is thick, the wine is described as "coarse," that from the higher slopes and hill tops as "thin" and "green." The best grades are made from grapes grown on the intermediate elevations and near the heart of the district. There is a saying that "good wine comes only from those places within sound of the creaking of the boat's rudder." In general, grapes of the heavier yields per acre produce the inferior

FIGURE 9.—Treading the juice out of the grapes to the accompaniment of an accordion.

grades of wine, while the best wines seldom represent a return of more than 360 gallons to 1,000 vines. The most of the port is made by blending, but occasionally there is an exceptionally good year—a "vintage year"—when the quality is so superior that it is kept separate and not mixed.

The period of the harvest, which begins about the last of October, is one of great picturesqueness and activity. The country awakens from its habitual calm into a scene of lively animation. Every able-bodied inhabitant is pressed into service, as well as still larger numbers of laborers including the "Gallegas" from northwest Spain who are imported for the tasks of the vintage. The vine-covered hills are dotted with gaily dressed women cutting the grapes, while sinuous lines of men, carrying the tall hampers filled with fruit, wind their way down the slopes to the great stone wine vats. As the harvest advances, even the nights become alive with activity, and the chants or cries of the treaders as they perform their monotonous task of treading out the juice disturb the usual stillness until the approach of midnight brings them a few hours of rest. Usually two treaders are allotted to each pipe (about 115 gallons) of wine. In some cases a second detail goes on duty at midnight and continues the treading until dawn when the first "shift" again replaces them.[2] A more sanitary method of extracting the must, by running the grapes between rollers, then pounding them with heavy wooden-tamps similar to those used by concrete workers, has been introduced in a few places, but the Douro is conservative, old customs die hard, and arguments based on sanitary considerations make little

[2] The workers are fed by the employers. A sample laborer's menu for the day: Breakfast: A salted sardine toasted on the coals, and a nip of spirits. Noonday: A thick soup of potato, beans, cabbage, macaroni, and rice, with a liberal supply of wine. Evening: The same as at noon with perhaps the addition of another sardine.

appeal, so the old method still largely prevails.

The wine is shipped in large oaken casks, and one of the chief items of Portuguese imports is oak lumber from the Baltic, the Upper Adriatic, and the United States for staves.

The bulk of the export, all of which as we have seen is compelled to pass through Oporto, goes to England. Some English houses purchase two- or three-year-old wine, store it for four or five years, and resell it in England at greatly enhanced prices. Shipments of port wine vie with sardines as the leading export item.

FIGURE 10.—A wine cart. The first step in the journey to the wine cellars of Oporto.

In 1924 port was first with a value of $7,496,000 out of a total of $31,310,000, or almost one-fourth of the value of all Portuguese exports. In quantity, port makes up only about 4 per cent of the total Portuguese wine production. The production per acre of port wine averages about 117.6 gallons, which is less than one-half of the average of all Portuguese wine—256.7 gallons.

The value of the crop varies widely from year to year. Thus, in 1923 the exports were valued at $4,250,000 or about 58 per cent of the value of all Portuguese wine shipments, while in 1924 it was worth $7,500,000 and made up 71 per cent of all wine so disposed of. Inasmuch as the wine is regarded to a certain degree as a luxury, the prosperity of the region depends in a corresponding measure upon economic conditions in foreign markets.

FRESH GRAPE INDUSTRY

The total production of fresh grapes in Iberia for table use is limited both in quantity and in geographical distribution. By far the largest part of the crop is raised in the valleys and upon the terraced slopes of the province of Almeria. This region is so rough that only 10 per cent is cultivable; so dry with its meager rainfall of only six inches (in 1913 it was only two inches) that irrigation must be resorted to even for the vine; so dependent upon foreign markets that in 1917, when ships failed to appear, 60 per cent of the crop spoiled. Although there are rich deposits of iron ore exploited by British interests, the majority of the people derive their living from agriculture, and the grape—the all-important crop—is grown on every morsel of land—valley, slope, and mountain top—provided only that water be available. As one might expect, cultural methods are in general primitive, and the people are poor and backward.

Owing to the exceedingly poor transportation facilities in the interior, those cultivators who do not live on one of the few main roads must depend upon the burros to carry their produce to market. Normally Spain ranks first among the countries of the world in the export of fresh grapes, with an annual total of about $6,000,000, of which Great Britain takes more than one-half and the United States one-third. From

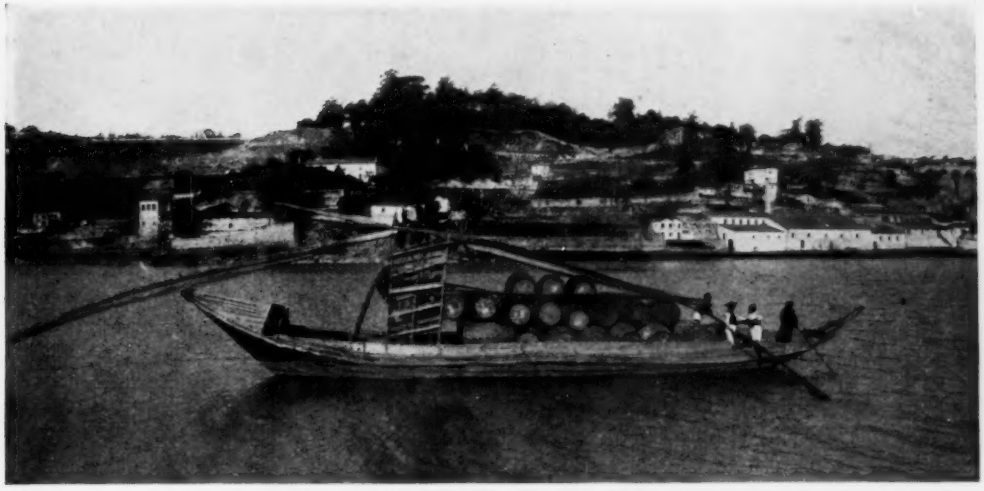

FIGURE 11.—A wine barque on the Douro.

1909–1913, shipments averaged almost 50,000 tons annually, and a good year sometimes sees as much as 70,000 tons exported. Portugal in the same period held sixth place with a shipment of 7,500 tons. To protect the fruit from damage on its oversea journey, about 1,200 tons of cork waste from the bottle stopper factories of Seville are used as packing.[3]

RAISINS

The raisin industry of Iberia finds its appropriate environment in the warmth and dryness of southern Spain. The bulk of the export crop is from the Malaga district with Campanillas as the chief center. Here is grown the large-sized grape which has won world-wide renown as the Malaga raisin. About Campanillas the vineyards are on a large alluvial plain underlain by a subterranean stream from which wells raise irrigation water as it is needed. The steps in the preparation of the product are shown in Figure 12. Of the total grape crop of Malaga province in 1925 about 55 per cent were used by the raisin industry. Its fresh grape output of some 45,000 barrels was insignificant beside the one and three-quarters million barrels of Almeria in the same year.

Because of its productiveness under the harsh climatic and topographic conditions prevailing over much of Iberia, as well as by reason of its importance in the diet and in foreign commerce, the grape will continue to occupy an important place in the agricultural scheme of both Portugal and Spain. Agriculture in Iberia is, however, backward and the illiteracy, conservatism, poverty, and commercial isolation make the adoption of modern scientific methods extremely slow. Consequently their wines have not as a rule carried the reputation or price of the French product,

[3] "At Alhama in the Almeria district some 20,000 to 25,000 barrels of grapes are produced annually. This locality has only one spring from which water issues and it is at a temperature of 115° F. After cooling, it is sold to the cultivators at unbelievable prices. Drinking water at Madrid sells for about 10 centimes per cubic meter, but here irrigation water costs over 75 centimes per cubic meter. It is estimated that the water needed to produce a barrel of grapes costs 20 pesetas or over $3.00 at present exchange." (G. Burke, U. S. Assistant Trade Commissioner in charge, writing in August, 1924.)

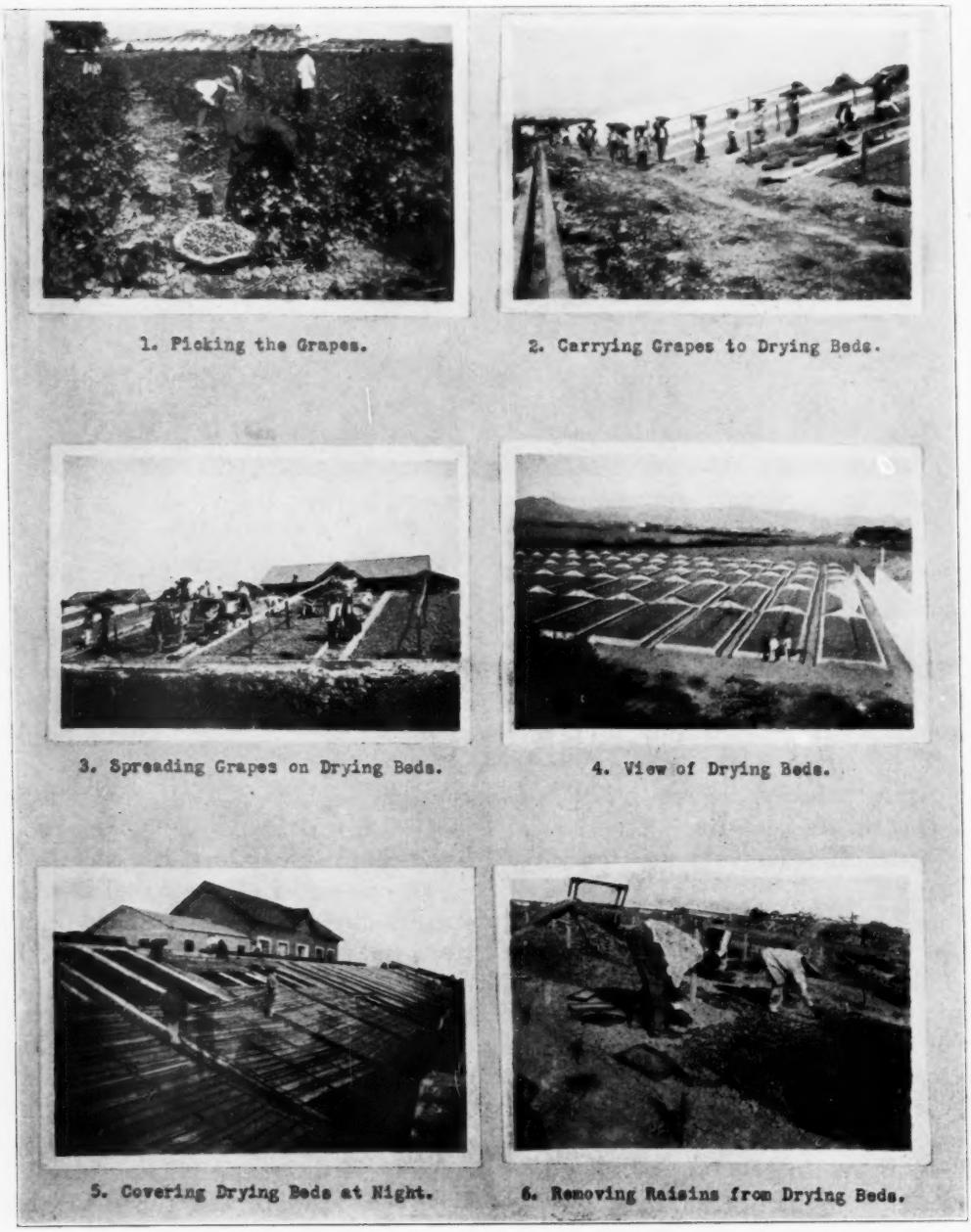
1. Picking the Grapes.
2. Carrying Grapes to Drying Beds.
3. Spreading Grapes on Drying Beds.
4. View of Drying Beds.
5. Covering Drying Beds at Night.
6. Removing Raisins from Drying Beds.

FIGURE 12.—The above illustrations show the various processes necessary in the preparation of raisins at Malaga, Spain. (Courtesy of A. G. Brady, American Consul, Malaga.)

and the prevention or control of diseases and pests has been difficult.

But, increased competition in the European and South American markets and the quarantining of infected produce by countries whose markets are highly prized are forcing Spanish exporters to modernize their methods. Likewise, it seems not too much to hope that they may soon learn to make more efficient use of the by-products of the grape industry.

Spain could be one of the world's greatest manufacturers of tartaric acid, but a survey in 1924 showed none being manufactured there. The available figures of 1922 indicate, on the other hand, that it exported over eleven million kilos of the crude materials—calcium tartrate, crude tartar, and wine lees—and in turn reimported the manufactured tartaric acid.

THE PHILIPPINE LUMBER INDUSTRY

Luis J. Borja

COLONEL CARMI A. THOMPSON, who was sent to the Philippines by President Coolidge to make a survey of the economic conditions there, reported that the Islands had vast timber resources from which a large part of the hardwood requirement of the United States may be supplied. Expert foresters, according to Colonel Thompson, say that the Philippine timber is 100 years overripe and is now deteriorating so that it should be cut and marketed in order to provide an opportunity for a new stand.

To bring more light on this subject, this article has been prepared with the object of bringing together the most important facts concerning the commercial forests of the Philippines and the exploitation and marketing of their products, which are perhaps of interest to the students of economic geography, manufacturers of hardwood products, and prospective promoters of the sawmill industry in the Islands.

Commercial Forests of the Philippines

The commercial forests of the Philippines (Fig. 1) cover an area of about 64,000 square miles, or about 57 per cent of the total area of the archipelago. The Philippine Bureau of Forestry places the available standing timber of the Islands ready for the saw at 200,000,000,000 board feet. This Bureau classifies and describes the commercial forests of the Philippines into the following types:

1. Lauan Type	Dipterocarp Family
2. Lauan-Lagachac Type	
3. Yacal-Lauan Type	
4. Lauan-Apitong Type	
5. Tanguile-Oak Type	
6. Molave Type	

Lauan Type

Similar woods having the name *lauan* predominate in this type of forest. It is the most important commercial forest in the Philippines. This type is found in regions with a short or no dry season and reaches its best development on the more gentle slopes near the base of the mountains. Its growth extends to an altitude of 100 to 130 feet, at which height it merges gradually into *tanguile-oak* type. In regions of rougher topography it does not produce such heavy stand. In rich soils it may occupy the low coastal hills, although near the sea it usually merges into the *yacal-lauan* type or the *molave* forest. The *lauan* type is comparatively free from jungle undergrowth, although it contains a very complex small tree flora and many climbing palms. Stripped of its ornaments of palms, lianas, epiphytic orchids, and ferns, the lauan forest bears striking resemblance to the commercial forests of the temperate zone.

Lauan-Lagachac Type

This type, like the *lauan* type, is confined to the regions where the dry season is short or wanting, and it is restricted to areas where the ground water level is near to the surface. It grows best in river bottoms, especially

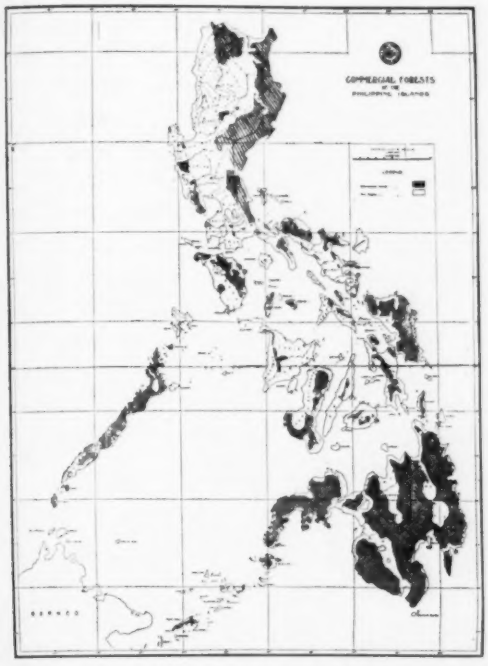

FIGURE 1.—The areas of potential commercial production are widely distributed throughout the Philippines, but most of the larger tracts are in the South.

on slightly raised river deltas and extends in narrow strips along the smaller streams through the *lauan* type, where it resembles this in character, and often they can scarcely be distinguished.

In composition it differs mainly from the *lauan* type in the presence of lagachac (*Dipterocarpus affinis*), and a much larger number of co-dominant species of other families. Where this forest has been analyzed carefully, it shows a large number of subtypes, which are often stages in succession, due to the unstable character of the habitat. In flood times, slight changes in the level of the soil due to deposits or formation of new water channels alters the relative height of the ground water level, which may be great enough to effect a decided change in the character of succeeding generations of trees.

Yacal-Lauan Type

This type finds its best development in regions of comparatively short dry season. It thrives best in coastal hills whose basal rock is volcanic in structure. It occurs on headlands projecting into the sea, especially those at the heads of embayments. These headlands usually have drier soils, lower relative humidity, and less rainfall than the region back of them. It also occurs on the hills bordering large river valleys that have approximately the same physical conditions. This type can be divided into two subtypes—ridge subtype, which occurs on the tops and exposed slopes of the ridges, where yacal is most abundant, and a subtype found on protected slopes of ravines and along small streams. It is difficult to draw a sharp line between these subtypes, inasmuch as they merge into each other and from the standpoint of the lumber man they are a unit. Hence, they are treated as one.

Lauan-Apitong Type

This type can stand a longer dry season, but so far as altitude and topography are concerned, it corresponds to the *lauan* type. During the dry season this type shows a decided deciduous element. Except in places of rich soils, the forest cover of this type is quite open, allowing the entrance of jungle undergrowth, lianas, bamboos, and the like.

Tanguile-Oak Type

The forests of this type cover the area extending from the upper limits of the *lauan* and *lauan-apitong* types to the lower limits of the mossy-forest type in the higher portion of the mountains. Its lower limits are from

FIGURE 2.—Interior view of the Lauan type of forest, the most important commercial forest in the Islands, found where there is little or no dry season. Note the straight, branchless boles.

1,250 to 1,600 feet above sea level, and it extends upward to a height of between 2,500 to 2,800 feet. The topography is such as is usually found on mountain sides, gentle to steep ridges and slopes alternating with deep ravines and gorges. The evergreen character of the forests and actual measurements show that rainfall is more evenly distributed throughout the year, and that the relative humidity is constantly higher than in the adjacent forests of the lower altitudes.

As its name implies, the principal species represented in this type are tanguile and oak; of these, the former also occurs frequently in *dipterocarp* types of the lower altitudes. It is found nearer sea level in regions where the dry season is short than in those where the dry season is longer, but in both its number increases with the altitude until the mossy-forest type is reached. Open places occur in this as in other types, giving rise to many subtypes. The undergrowth trees are numerous, but the composition is not as complex as the types below. The closed portions of the forests are comparatively free from large lianas other than rattans; so that the only difficulty in penetrating the forest in any direction is encountered in the tangled growth of the open places.

FIGURE 3.—The Lauan-Lagachac type of forest is restricted to areas where the groundwater level is near the surface, growing best in river bottoms and on deltas. It is a valuable commercial type.

Molave Type (Vitex Parviflora)

This type occupies a topography similar to that on which the *yacal-lauan* type is found, except that in a majority of cases the underlying rock is usually limestone rather than

volcanic in nature. The low limestone hills, either coastal or bordering large uplifted river valleys, are usually composed of crystalline coral limestone with honeycombed structure. These rocks are generally covered by shallow or very scanty soil, and this, together with their honeycombed nature, makes the habitat a very dry one. It is roughly estimated that the area covered by this type comprises about 4,000 square miles. The trees are the most valuable in the Philippines and are easily accessible for exploitation. This has brought about a more or less complete destruction of the original forest; so it is very difficult to analyze the true nature of the vegetation. From the study of virgin and nearly virgin areas, however, the following characteristics seem to be most general. The forest is open. Its large trees are few and far apart, the intervening spaces being filled with small trees or by a jungle growth usually of sprawling, climbing, or small erect bamboos. With a few exceptions the dominant trees are short-boled, irregular to very irregular in form and widespreading crowns. The forest has a decided deciduous foliage, almost entirely so on rough topography in regions where the dry season is pronounced. The compositions of the type vary in different parts of the Islands.

FIGURE 4.—The Yacal-Lauan type finds its best development on coastal hills of volcanic rock with short dry seasons. The logs are many of great size. Carabao still constitute the chief transportation power.

As one would suppose, the volume of the *molave* type is much lower than that of any of the *dipterocarp* type, due both to the thin stand and to the short boles of the trees. It is estimated that this type of forest averages not more than 3,000 board feet to the acre. Nevertheless, this type is a valuable one because it contains hard, durable timbers, many of which are valuable cabinet and furniture woods, which have a wide market abroad.

FIGURE 5.—A fine stand of timber in the Lauan-Apitong type of forest, growing where the dry season is relatively long. This type contains a strong deciduous element.

CHARACTER AND GENERAL USES OF PHILIPPINE WOODS

On the basis of their qualities of strength, durability, and special uses, the Philippine woods may be divided into four groups. The first group includes the hard, heavy, strong, and durable woods suitable both for heavy exposed construction work in the tropics and for high-grade cabinet work. Some softer, less durable woods which are valuable for special uses, such as cigar boxes and wood carving, are also included in this group. Typical of the harder and heavier woods are *yakal, narra, ipil, tindalo, camagon, ebony, akle, and molave.* Other woods of softer quality which are also included in this class are *batikuling, kalantas, bakan,* and *kaburo,* none of which are found in great commercial quantities.

The second group is also made up of durable and strong woods, but these do not rank as high as those in the first group. Most of the species of this grade are found in such small quantities that they are comparatively little known on the market. Typical of this group are *banuyo, makaasim, guijo,* and *manggachapui.* The last two are the only ones that are obtainable in commercial quantities.

The third group contains species found in the largest commercial quantities. These woods are most commonly used, but, being softer and less durable under tropical conditions, they cannot be classed with the harder, heavier, and more fancy woods of the two higher grades. Most of the export timber such as *tanguile, red lauan, lumbayao,* and *mayapis* come from this group. These woods have excellent figure and finishing qualities for cabinet work and interior finish, the first two being sold as "Philippine mahogany" in America and Europe. *Apitong,* a well-known export wood of a somewhat harder grade, is also included in this group.

In the fourth group, most of the woods are either not found in commercial quantities or are not of the quality suitable for export. Notable exceptions, however, are white lauan, almon, and several woods belonging to the lauan family, including *manggasinoro* and *bagtikan,* which are classed as the lighter colored grades of "Philippine mahogany" in the American and other foreign markets.

USES OF PHILIPPINE WOODS IN THE UNITED STATES

According to the Department of Commerce, American dealers of Phil-

FIGURE 6.—The Tanguile-Oak type of forest occupies mountain side areas between 1,200 and 3,000 feet altitude, with rather even rainfall throughout the year.

ippine mahogany have supplied the following information as to their uses in the United States:

Red Philippine mahogany (tanguile and red lauan) has been used very extensively on the Pacific coast and elsewhere for the interior trim of office buildings, hotels, and department stores.

White Philippine mahogany (including almon and white lauan) has also been used to a considerable extent for cabinet work, furniture and building trim, frequently with walnut stain. Several years ago 300,000 board feet of Philippine mahogany was sold to a firm manufacturing talking machines. Automobile and truck body builders use it for deck houses and other purposes. Though it is somewhat resinous, the resin does not break out through the varnish if the lumber is thoroughly dried before finishing. Apitong is meeting with a great deal of favor where a reasonably priced, tough, close-grained wood is required.

Guijo is easy to finish and consequently is a good wood for building trim. It also makes a serviceable hardwood floor by reason of its hardness and beauty. It shows the mahogany figure when finished.

Yakal, the hardest and the heaviest of the dipterocarp family and the most abundant of the hard, heavy, and durable woods in the Philippines, can be put to a number of uses. For tool handles of all kinds, wagon tongues, vehicle parts, and spokes, yakal is suitable. Guijo is also adapted to these uses.

Narra is one of the very hardwood figured woods found in the Islands and used largely in cabinet work and fine furniture. Its coloring ranges from very pale yellow, through all shades of salmon and red, to deep blood red. This wood was used extensively by the Pullman Company for the interior finish of its cars before the all-steel sleeping car was adopted.

Flooring manufactured in the Philippines has been imported and used in California. Apitong is the wood principally used for flooring, although guijo has also been imported in that shape.

Veneers, veneered panels and table

FIGURE 7.—Modern efficient methods of logging have been introduced into some of the Philippine timber tracts, the donkey engine superseding the carabao.

tops of tanguile, red lauan, white lauan, as well as built-up doors and door stock of the same wood, are manufactured in the Philippines and shipped to the United States.

The usual method of marketing has been under the name of "Standard red Philippine mahogany," consisting of tanguile and red lauan mixed, and white Philippine mahogany, consisting of almon and white lauan. The grading has been in most cases according to the rules of the National Hardwood Lumber Association, which allow wormholes, but the demand for wood that is free of wormholes has made an exception to these rules necessary. Some dealers, therefore, sell on the basis of "first" being free from wormholes and "second" permitting wormholes. The combined grade of "FAS" will thus contain 50 per cent free of wormholes and 50 per cent with this defect. The wormholes being small, they do not seem to affect the use of the wood. Other dealers sell on the basis of firsts and seconds "free of wormholes" or "with wormholes allowed," as the case may be.

This seeming diversity in the grading of Philippine mahogany is not so confusing as it at first appears. The only distinction in the upper grade is wormholes, so that the phrase "free of wormholes" attached to "firsts and seconds" will clearly define the article required. The presence of sap and the size of the boards, shorts and narrows, for instance, determine in a larger measure the lower grade.

THE SAWMILL INDUSTRY

At the time of the American occupation of the Philippines, the lumber industry was confined very largely to the cutting of the highest grade cabinet and construction woods. Logging was practically confined to hand and animal methods and, with the exception of five or six mills in Manila and in the provinces, the sawing of lumber was largely done by hand.

The large amount of construction work following the American occupation and the reëstablishment of peace conditions, however, created a big demand for lumber with the result that by 1903, fourteen sawmills were installed in the Philippines. The total cut of these mills amounted to about 15,000,000 to 20,000,000 board feet per annum. Since then, the lumber industry has grown, and today there are about sixty-seven modern mills in active operation, some of which are using modern steam logging machinery. These mills produce about 200,000,000 board feet annually, of which about 50,000,000 are exported.

The Insular Lumber Company, whose capacity is 50,000,000 board feet per annum, is now the world's largest producer of hardwood lumber. It was organized in 1904 with small capital. The company enlarged its mill in the years 1906, 1912, and 1918, but it was not until 1922 that the whole plant was completely rebuilt and enlarged to its present capacity. This company has its head office in Philadelphia, and has several sales agencies in the United States. The plant is located at Fabrica, in the province of Negros Occidental.

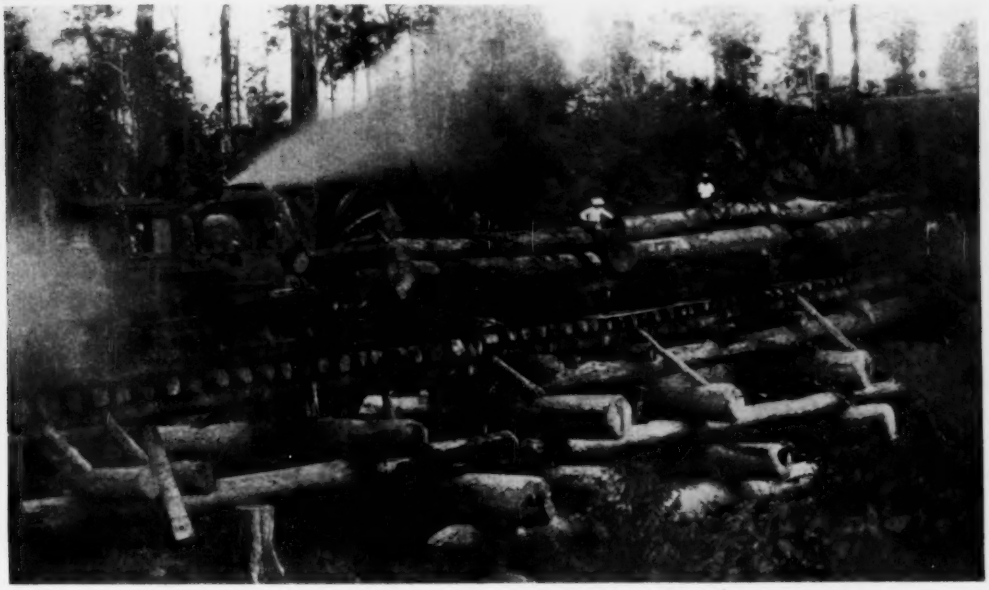

FIGURE 8.—Logging operations of considerable magnitude now distinguish the larger and more successful holdings. Lumber railroads and steam locomotive power transportation are fairly common.

LABOR SUPPLY

The present lumber industry offers a permanent employment to about 20,000 native laborers. While other industries generally complain of lack of labor, the lumber industry usually has a sufficient supply. In some cases, however, it is necessary to import laborers from the thickly settled regions to the remote places where logging operations are carried on.

As to the merits of the native laborers, it may be of interest to quote Mr. J. O. Bradney, the general manager of the Insular Lumber Company, in his article in the February,

1926, issue of *The American Chamber of Commerce Journal*, Manila:

As to the Filipino, our experience can be duplicated any place in the Philippines by approaching the Filipino from the lowest to the highest rank in a spirit of good understanding and in recognition of the fact that he and his people are just folks like us. He will accept responsibility, his physical limitation, experience and past opportunity considered, with as much courage and tenacity in the execution of his work as any other man or group of men within the tropical zones. We have Filipino heads of departments at Fabrica whose services are beyond price and whom it would be difficult indeed to replace. There are employed at Fabrica over 2,500 Filipinos, and among this number there are approximately 600 who have been upon the pay roll of the Insular Lumber Company anywhere from two to fifteen years. There is, of course, a large overturn of Filipino labor due to so many varying conditions as to put them beyond practical enumerations, but the mainstay of our staff is quite as consistent and devoted to duty and good service as any other living people.

EXPORTS OF LUMBER FROM THE PHILIPPINES, 1924 AND 1925

Country to Which Exported	*1924*	*1925*
	Board Feet	Board Feet
United States	23,036,768	25,185,600
Guam	.....	3,810
United Kingdom	5,001,080	2,482,944
Canada	89,888	424,848
Australia	4,041,568	9,136,776
British East Indies	.....	60,208
Hongkong	184,016	214,968
China	6,276,472	7,013,384
Japan	12,053,896	6,735,240
France	.....	2,120
Hawaii	7,208	.....
Spain	8,480	848
Italy	848	31,800
Belgium	46,640	11,624
Netherlands	.....	256,096
Egypt	.....	636,424
Germany	.....	20,776
Total	50,746,864	52,217,476

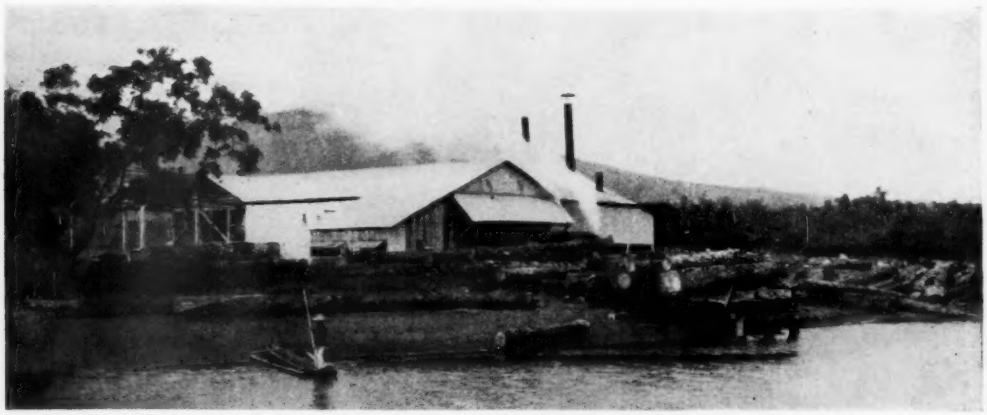

FIGURE 9.—One of the modern steam sawmills utilizing the fine timber of the Philippines.

In the years 1924 and 1925, the United States continued to lead in the importation of the so-called Philippine mahogany (tanguile and lauan), while Australia (where the same is marketed under the trade name of Pacific Maple) jumped from fifth place in 1924 to second place in 1925. Exports to the United States in 1925 increased slightly over the previous year, while that of Australia had doubled, importing over a million board feet as compared with slightly over 4,000,000 board feet in 1924. Exports to Japan, however, dropped from about 12,000,000 board feet in 1924 to about 7,000,000 board feet in 1925. Philippine lumber in the Chinese market held its own in spite of the civil war, registering a light increase in 1925 over that of the previous year. The decrease of exports to Japan and other European countries in 1925 was counteracted by the exports to the United States and Australia and by the opening of the new markets.

BOOK REVIEWS

DEPARTMENT OF COMMERCE

Bureau of Foreign and Domestic Commerce

Foreign Markets for Irrigation Machinery and Equipment. Trade Promotion Series No. 73, in collaboration with the Bureau of Reclamation. Price, 30 cents.

During the past 50 years much progress has been made in the method of irrigating land. In many countries the only land available is either arid or semi-arid, many acres of which, by means of modern irrigation methods initiated and financed by governments or associations of farmers, are now producing excellent crops. There are approximately 200,000,000 acres now under irrigation throughout the world. This is only a small fraction of the hundreds of millions of acres which could be made to produce crops if modern irrigation methods were used. More of this land is being brought under irrigation each year, and modern irrigation machinery is rapidly replacing the old makeshift equipment formerly employed. The information contained in this bulletin was gathered by means of a questionnaire sent out to all foreign offices of the Department of Commerce and the Department of State throughout the world. As customs statistics do not list exports of irrigation machinery, it is not possible to give definite figures of the amount of this equipment going into our foreign commerce. There is an indication, however, that exports of it are increasing.

Motor Roads in South Africa. By B. P. Root. Trade Promotion Series No. 70. Price, 20 cents.

With the development of South Africa the good roads are being extended. The motor car has become a practical necessity there and large quantities are imported annually. Rural development has also encouraged motor transport service, since many districts which can not provide remunerative railway traffic can be adequately served by motor transport. During the past year the motor-feeder service of South African railways has tripled. This bulletin includes some excellent maps.

Reconstruction and Development of the Tokyo-Yokohama District. By J. H. Ehlers. Trade Promotion Series No. 69. Price, 30 cents.

Reconstruction following the earthquake of 1923, was deferred as far as permanent structures were concerned until (a) a new building code providing for earthquake-proof structures could be developed; (b) a decision regarding a city plan could be made; (c) problems associated with condemnation for streets, parks, and other projects, also means of financing, could be solved. Reconstruction of Japan's devastated areas, instead of moving forward in 1923–1924, became more a matter for 1928–1929, and it is largely for the purpose of giving a clearer understanding for the work that lies ahead that Mr. Ehlers has prepared this report. This report is a summary statement of Mr. Ehlers' complete and detailed engineering analysis. Plans, pictures, and specific data on which an American engineer might wish to base his bids are contained in the complete report now filed but available for consultation in the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce.

Foreign Markets for United States Eggs. By M. A. Wulfert. Trade Information Bulletin No. 584. Price, 10 cents.

Exports of eggs from the United States were more than five times greater in 1927 than in 1910. Shipments to Cuba, the principal market, which takes over 40 per cent of our egg exports, are on a downward trend. In the foreign markets in which the United States eggs are sold there is but little competition with other countries, except in Great Britain, and the expansion of these markets depends largely upon economic conditions within the countries. A discussion of these markets will be found in this bulletin.

International Trade in Corn. By Theo. D. Hammatt. Trade Information Bulletin No. 591. Price, 10 cents.

Corn exceeds in tonnage and value any other crop grown in the United States, but the production is accompanied by a domestic demand that, as a rule, leaves meager quantities available for export. Nevertheless, the exports from the United States form a considerable part of the total oversea movement and are a somewhat important factor in the price at which corn moves in international trade.

Markets for Fresh Fruit in the Netherland East Indies. By Don C. Bliss. Trade Information Bulletin No. 587. Price, 10 cents.

Within the past two years there has been considerable interest shown by United States exporters on the Pacific coast in the markets for fresh fruit in the Far East. To supply these exporters with timely and comprehensive trade data, representatives of the Bureau of Foreign and Domestic Commerce in the Far East have been giving special attention to the possibilities of marketing fresh fruit in their respective territories. This bulletin embodies the results of a survey by one of the Bureau's foreign representatives of the market in the Netherland East Indies.

British Market for American Dairy Equipment and Supplies. By Brice M. Mace, Jr. Trade Information Bulletin No. 598. Price, 10 cents.

The United Kingdom ranks second only to Canada as a market for American dairy equipment, absorbing during the past three years an average value of $98,000, compared with an average of $70,900 taken by Australia, which holds third place. American dairy equipment is well suited to the British dairy industry; in fact, it is in many instances regarded as standard, and certain lines have been copied by both British and continental competitors.

Radio Markets of the World, 1928–1929. By Lawrence D. Batson. Trade Information Bulletin No. 600. Price, 15 cents.

The importance of foreign markets for radio equipment is attested by the value of United States exports. During the past seven calendar years over $50,000,000 worth of American radio goods has been sent to foreign countries. This bulletin presents information as to the basic character of the various markets and will serve as a reliable guide for the exporter of radio goods. It covers all countries of the world and gives for each full information on the particular conditions that affect the use of radio apparatus.

Ceylon: Its Industries, Resources, Trade and Methods of Doing Business. By Mason Turner. Trade Information Bulletin No. 601. Price, 10 cents.

Ceylon is rich in resources, history, and legend, and, lying under the Equator as it does, its high altitudes with their cooling breezes constitute a veritable oasis for the traveler from the sun-scorched plains of southern India.

The following Trade Information Bulletins were issued:

The Marketing of Manganese Ore. By J. W Furness. Trade Information Bulletin No. 599. Price, 10 cents.

French National Finance and Stabilization. By Henry C. MacLean. Trade Information Bulletin No. 586. Price, 10 cents.

Advertising Automotive Products in Australia, Japan, and Islands of the Pacific. By J. A. G. Pennington. Trade Information Bulletin No. 589. Price, 10 cents.

International Trade in Furs. By Thomas J. Biggins. Trade Information Bulletin No. 590. Price, 10 cents.

Sources of Foreign Credit Information, Revised, 1928. By A. S. Hillyer. Trade Information Bulletin No. 292 (Revised). Price, 10 cents.

Uniform Through Export Bill of Lading (Revised, 1928). By A. Lane Cricher. Trade Information Bulletin No. 593. Price, 10 cents.

Trade Financing and Exchange in Porto Rico and Haiti. By H. H. Dashiell, and Samuel H. Honaker. Trade Information Bulletin No. 595. Price, 10 cents.

The Electrical Equipment Market in Spain. By Electrical Equipment Division. Trade Information Bulletin No. 596. Price, 10 cents.

French and German Inland Waterways. By E. T. Chamberlain. Trade Information Bulletin No. 597. Price, 10 cents.

Supplement to Annual List of Publications. Compiled monthly by the Division of Publications of the Department of Commerce. This may be obtained without charge upon request to the Chief of Division of Publications. It enables the user to keep in touch with the current publications of the Department of Commerce.

Monthly Summary of Foreign Commerce of the United States, Parts I and II, for December, 1928, present a complete summary of the foreign trade of the United States for 1928. Subscription $1.25 per year. Single copies, Part I, 10 cents; Part II, 5 cents.

BUREAU OF MINES

The following separates from the Mineral Resources of the United States for 1927 have been issued by the Department of Mines:

Iron Ore, Pig Iron and Steel in 1927—Part I (pp. 75–113). By Hubert W. Davis. Technical Paper I: 6. Price, 10 cents.

Arsenic, Bismuth, Selenium and Tellurium in 1927—Part I (pp. 115–118). Technical Paper I: 7. Price, 5 cents.

Tin in 1927. By J. W. Furness. Technical Paper I: 8. Price, 10 cents.

Manganese and Manganiferous Ores in 1927. By J. W. Furness. Technical Paper I: 9. Price, 10 cents.

Silver, Copper, Lead, and Zinc in the Central States in 1927. By J. P. Dunlop and H. M. Meyer. Mine Report. Technical Paper I: 10. Price, 10 cents.

Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1927. By James M. Hill. Mine Report. Technical Paper I: 11. Price, 10 cents.

Gold, Silver, Copper, and Lead in South Dakota and Wyoming in 1927. By Charles W. Henderson. Mine Report. Technical Paper I: 12. Price, 5 cents.

Chromite in 1927. By J. W. Furness. Technical Paper I: 13. Price, 5 cents.

Gold, Silver, Copper, Lead, and Zinc in New Mexico and Texas in 1926. By Charles W. Henderson. Mine Report. Technical Paper I: 27. Price, 5 cents.

Gold, Silver, Copper, Lead and Zinc in Colorado in 1926. By Charles W. Henderson. Mine Report. Technical Paper I: 28. Price, 10 cents.

Falls of Roof in Bituminous Coal Mines. Influence of the Seasons and Rate of Production. By J. W. Paul. Technical Paper 410. Price, 10 cents.

Roasting of Lead-Carbonate Ores Preliminary to Gravity Concentration. By Virgil Miller and R. E. Head. Technical Paper 413. Price, 10 cents.

Studies in the Fractional Distillation of Crude Petroleum. By M. B. Cooke and H. P. Rue. Technical Paper 431. Price, 15 cents.

Bentonite: Its Properties, Mining, Preparation, and Utilization. By C. W. Davis and H. C. Vacher. Technical Paper 438. Price, 10 cents.

Salt, Bromine, and Calcium Chloride in 1927. By A. T. Coons. Technical Paper II: 12. Price, 5 cents.

Gypsum in 1927. By R. M. Santmyers and Jefferson Middleton. Technical Paper II: 13. Price, 5 cents.

Natural Gas in 1927. By G. R. Hopkins and H. Backus. Technical Paper II: 14. Price, 5 cents.

Lime in 1927. By A. T. Coons. Technical Paper II: 15. Price, 5 cents.

Sand and Gravel in 1927. By Estelle R. Phillips. Technical Paper II: 16. Price, 5 cents.

Magnesium and Its Compounds in 1927. By J. M. Hill. Technical Paper II: 17. Price, 5 cents.

Talc and Soapstone in 1927—Part II (pp. 181–186). Technical Paper II: 18. Price, 5 cents.

Mica in 1927—Part II (pp. 187–198). By B. H. Stoddard. Technical Paper II: 19. Price, 5 cents.

Natural Gasoline in 1927. By G. R. Hopkins. Technical Paper II: 20. Price, 5 cents.

Stone in 1927—Part II (pp. 209–245). By A. T. Coons. Technical Paper II: 21. Price, 10 cents.

Barite and Barium Products in 1927. By R. M. Santmyers. Technical Paper II: 22. Price, 5 cents.

Clay in 1927—Part II (pp. 257–268). By Jefferson Middleton. Technical Paper II: 23. Price, 5 cents.

Cement in 1927—Part II (pp. 269–298). By B. W. Bagley. Technical Paper II: 24. Price, 5 cents.

Asbestos in 1927—Part II (pp. 299–311). By Oliver Bowles and B. H. Stoddard. Technical Paper II: 25. Price, 5 cents.

Coke and By-Products in 1926—Part II (pp. 587–675). By F. G. Tryon, H. O. Rogers, and H. L. Bennit. Technical Paper II: 30. Price, 15 cents.

Mineral Resources of the United States in 1927 (Preliminary Summary). Introduction by Frank J. Katz, Statistics Assembled by Martha B. Clark.

This summary statement of mineral products within the United States presents briefly the figures for 1927 and makes them available long before the complete report is issued.

BUREAU OF FISHERIES

Stocking Interior Waters of the United States. By E. C. Fearnow and M. C. James. Price, 5 cents.

Oyster Bottoms of North Carolina. By Dr. Paul S. Galtsoff and H. R. Seiwell. Price, 5 cents.

Shrimp Fishery of Southeast Alaska. By Frank W. Hynes. Price, 10 cents.

Scallop Industry of North Carolina. By James S. Gutsell. Price, 10 cents.

Alaska fishery and Fur-Seal Industries in 1927. By Ward T. Bower. Document No. 1040. Price, 25 cents.

Progress in Biological Inquiries 1927. By Elmer Higgins. Document No. 1044. Price, 10 cents.

Statistical Review of the Alaska Salmon Fisheries. Part I: Bristol Bay and the Alaska Peninsula. By Willis H. Rich and Edward M. Ball. Document No. 1041. Price, 20 cents.

Natural History and Conservation of the Redfish and Other Commercial Sciaenids on the Texas Coast. By John C. Pearson. Document No. 1046. Price, 30 cents.

Condition of the Razor-Clam Fishery of Washington. By H. C. McMillin. Price, 5 cents.

Fisheries Service Bulletin. Compiled monthly by the Bureau of Fisheries. This service may be obtained without charge from that Bureau.

U. S. COAST AND GEODETIC SURVEY

Topographic Manual. By O. W. Swainson. Special Publication No. 144. Price, 30 cents.

This manual gives the general requirements of the U. S. Coast and Geodetic Survey for the execution of topographic surveys and to describe the instruments and methods used for topographic work. It contains some interesting and valuable material for use of geographers in connection with their field work.

Earthquake History of the United States, Exclusive of the Pacific Region. By N. H. Heck. Special Publication No. 149. Price, 15 cents.

Comparison of Old and New Triangulation in California. By William Bowie. Special Publication No. 151. Price, 15 cents.

Seismological Report, October, November, December, 1926. By Frank Neumann. Serial Number 431. Price, 10 cents.

United States Coast Pilot, Atlantic Coast, Section D, Cape Henry to Key West. Price, 75 cents.

Tide Table, New York Harbor and Vicinity, 1929. Price, 5 cents.

Tide Table, Boston Harbor and Vicinity, 1929. Price, 5 cents.

Supplement to United States Coast Pilot, Pacific Coast (1926 Edition). California, Oregon, and Washington. Serial No. 436.

Supplement to Inside Route Pilot, Key West to the Rio Grande. Serial No. 434.

BUREAU OF STANDARDS

Unidirectional Radiobeacon for Aircraft. By E. Z. Stowell. Research Paper No. 35. Price, 10 cents.

The Analysis of Fluorspar. By G. E. F. Lundell and J. I. Hoffman. Research Paper No. 51. Price, 5 cents.

Report of the Twenty-First National Conference on Weights and Measures. Attended by Representatives from Various States, Held at the Bureau of Standards May 22, 23, 24, and 25, 1928. Misc. Publications, No. 87. Price, 35 cents.

AERONAUTICS BRANCH

Report of Airway Marking Committee. No charge.

Supplement to Directory of Licensed Pilots. Supplement 2 to Bulletin 20. No charge.

Airports and Landing Fields. Aeronautics Bulletin No. 5. No charge.

Aeronautical Publications. Aeronautics Bulletin No. 6. No charge.

BUREAU OF THE CENSUS

Financial Statistics of Cities having a Population of over 30,000. 1926. Price, $1.25 (Buckram).

Census of Religious Bodies for 1926, are as follows:

Pillar of Fire. Statistics, Denominational History, Doctrine, and Organization. No. 59. Price, 5 cents.

Plymouth Brethren. Statistics, History, Doctrine, and Organization. Consolidated Report No. 61. Price, 10 cents.

The Christian Science Parent Church (The Church of the Transforming Covenant). Statistics, History, Doctrine, and Organization No. 63. Price, 5 cents.

Presbyterian Bodies. Statistics, Denominational History, Doctrine, and Organization. Consolidated Report, No. 64. Price, 15 cents.

Assemblies of God, General Council. Statistics, Denominational History, Doctrine, and Organization. No. 65. Price, 5 cents.

Divine Science Church. Statistics, Denominational History, Doctrine, and Organization. No. 66. Price, 5 cents.

Assyrian Jacobite Apostolic Church. Statistics, History, Doctrine, and Organization. No. 67. Price, 5 cents.

Temple Society in America. Statistics, History, Doctrine, and Organization. No. 68. Price, 5 cents.

Disciples of Christ. Statistics, Denominational History, Doctrine, and Organization. No. 69. Price, 5 cents.

Mennonite Bodies. Statistics, Denominational History, Doctrine, and Organization. Consolidated Report No. 70. Price, 10 cents.

Liberal Catholic Church. Statistics, History, Doctrine, and Organization. No. 71. Price, 5 cents.

African Orthodox Church of New York. Statistics, Denominational History, Doctrine, and Organization. No. 72. Price, 5 cents.

Baháis. Statistics, History, Doctrine, and Organization. No. 73. Price, 5 cents.

Apostolic Overcoming Holy Church of God. Statistics, Denominational History, Doctrine, and Organization. No. 74. Price, 5 cents.

Church of Christ (Holiness). Statistics, Denominational History, Doctrine, and Organization. No. 76. Price, 5 cents.

Free Church of God in Christ. Statistics, Denominational History, Doctrine, and Organization. No. 78. Price, 5 cents.

Pentecostal Assemblies of the World. Statistics, Denominational History, Doctrine, and Organization. No. 80. Price, 5 cents.

Churches of God, Holiness. Statistics, Denominational History, Doctrine, and Organization. No. 81. Price, 5 cents.

Lithuanian National Catholic Church of America. Statistics, History, Doctrine, and Organization. No. 83. Price, 5 cents.

Latter-Day Saints. Statistics, Denominational History, Doctrine, and Organization. No. 86. Price, 5 cents.

Eastern Orthodox Churches. Statistics, History, Doctrine, and Organization. Consolidated Report, No. 88. Price, 10 cents.

Lutherans. Statistics, History, Doctrine, and Organization. Consolidated Report No. 98. Price, 20 cents.

Free Christian Zion Church of Christ. Statistics, Denominational History, Doctrine, and Organization. No. 90. Price, 5 cents.

Social Brethren. Statistics, Denominational History, Doctrine, and Organization. No. 91. Price, 5 cents.

Cotton Production and Distribution. Season of 1927–1928. Bulletin No. 164. Price, 10 cents.

The Growth of Manufactures 1899 to 1923. A study of Indexes of Increase in the Volume of Manufactured Products. By Edmund E. Day and Woodlief Thomas. Census Monographs VIII. Price, $1.35.

RADIO DIVISION

Radio Service Bulletin. Compiled monthly by the Radio Division. Subscription Price, 25 cents per year; 5 cents per copy.

Amateur Radio Stations of the United States. Edition—June 30, 1928. Price, 25 cents.

AMERICAN MARINE STANDARDS COMMITTEE

Stability and Loading of Ships. Final Report of the Special Committee on Stability and Loading of the American Marine Standards Committee. A. M. S. C. 51. Price, 15 cents.

HELEN M. STRONG.

WHEELER, L. RICHMOND. *The Modern Malay.* 283 pages, ills., bibliography. George Allen and Unwin, Ltd., London, 1928. Price, 15/.

In the preface of his book, the author states that his object "is to give an account of the Malay race as it is at the present day." The author lives in Malaya and knows Malays; thus it is hardly surprising that the book is a first-hand, reliable, though not exhaustive, account of the Malays of the Peninsula.

Malaya, like Japan, has undergone an amazing transformation since the sixties. Much that has been written a relatively short time ago is now quite out of date. Therefore, a study of present conditions is particularly welcome, as well as illluminating and provocative of thought.

The theme is the Malay of today, but because the present is in the main a development out of the past the bulk of Part II, entitled "Early Influences," and Part III, "Recent Influences," is devoted to an epitome of the history of the past insofar as this is pertinent to the present—an epitome of special value, for the past history of the Malays is exceptionally chequered and frequently obscure. Fortunately, the author does not limit himself to the historical aspect. He touches also the ethnographical, geographical, political, and cultural aspects, involving the interpretation as well as the statement of facts.

Part IV is concerned with "Present Conditions," Part V with "The Present Response." These two parts furnish a suggestive study of some of the varied activities of a paternal government with socialistic tendencies, working in the interests of the most indigenous group in an area of mixed peoples, and of some of the salient reactions. Education, land administration, as well as the cinematagraph and Islamism, are treated as formative forces.

Nor is the author content with the past and present. He dares in Part VI to forecast "The Future of the Peninsula Malays"—a forecast which involves critical treatment of the tendencies of today, and raises a number of topical subjects, such as, "Are the Malays a dying race?", "Is it worth while fostering the Malays?", "British Imperialism."

For the ordinary student the book is a useful starting point, and the bibliography, given at the end, is a valuable guide to further reading. For those interested in international affairs, here "is an excellent example of how many diverse races and classes can live and work together in harmony and fellowship."

IRENE J. CURNOW.

PARSONS, FLOYD W., Editor. *New Jersey.* 404 pp., ills. New Jersey Chamber of Commerce, Newark, 1928. $3.50.

In this publication, the first of its kind in the country, the reader gets a comprehensive and vivid presentation of the life, industries, and resources of a great state. Unlike many contributions of chambers of commerce, this volume lists among its contributors scores of specialists, including authors, business executives, college and university professors, economists, scientists, and special writers, and is particularly free from bombast and extravagant commendation. Here is a book that every geographer interested in *North America* will want to possess.

So excellent is Mr. Parson's preface that the reviewer quotes much of it verbatim:

"There is real need in America for a wider and more complete understanding of the life, resources and industries of the different states. While the people of our country are bound together by one national Government, we are divided by the boundaries of 48 separate and distinct commonwealths. Our habits and thoughts are influenced by such natural endowments as climate, topography, water, minerals, and timber. Citizens of Florida, New Jersey, Montana, and Utah cannot all have the same viewpoint. We are part of our environment, and it varies from semi-tropical to snowbound—from sea level to the high altitudes of the Rockies.

"Not only do we suffer from sectionalism that limits our appreciation of the problems of our neighbors, but we are sadly deficient in our knowledge respecting the noble traditions, advantages, and opportunities of the particular state in which we reside. . . .

"It is to supply information of such a character that this practical outline of New Jersey's past and present activities has been prepared. . . . The result is a volume that will fill a want never before satisfied. . . ."

While all thirteen chapters make interesting and profitable reading, the following are recommended to geographers:

II. Geology and Mineral Resources, Geography, Climate, Forest Resources, Fishery Resources. (A relatively brief but illuminating treatment of the state's natural environment.)

V. Agriculture, Farm Crops, Soils and Fertilizers, Human and Animal Nutrition, Agricultural Marketing, Vegetable Growing, Dairying, Poultry, Ornamental Horticulture, Fruit Growing, Livestock, Combating Agricultural Enemies, Agriculture and Education, Farms of Distinction. (A scholarly and vivid account of all aspects of agriculture. Much excellent agricultural geography.)

VII. Transportation and Commerce, Railways, Great Bridges and Tunnels, Ports and Terminals, State Highways, Trucking, Aviation. (Undoubtedly the best chapter in the book; a notable contribution.)

XI. Growth and Importance of Industry, Great Industries—Petroleum Refining, Silk, Cotton, and Fabricated Products, Ceramics, Jewelry Making, Machine Industry, Electrical Industry, Shipbuilding Industry, Tobacco Industry, Leather Industry, Paint and Varnish Industry, Canning Industry, Packing Industry, Mineral Industries, Glass Industry, Baking Industry, New Jersey's Great Firms. . . . (A rich mine for the industrial geographer.)

XIII. New Jersey Tomorrow. (A forecast of the New Jersey of tomorrow; interesting and well done.)

The volume is capitally illustrated with eight pages in color and 408 half-tones. One page of graphs also tells effectively and briefly the story of the state's industry and labor.

So excellent in general is the book that one hesitates to criticize it. Yet in two respects it is weak: first, it has no index, and second, it has no maps of any kind. This latter omission is a most unfortunate one, since there are innumerable references to bays, rivers, mountains, plateaus, gaps, plains, physiographic provinces, counties, cities, towns and villages, and railroads. It is exasperating to try to interpret the human adjustments to the natural environment without a detailed map to refer to. True, one may use an atlas, but most atlases are not satisfactory for the details of individual states. Moreover, it cannot be argued that the denizens of any state know the *place geography*, for they do not. Any teacher of geography will attest the truth of this statement. Accordingly, because of the omission of several well-planned maps, every reader must needs miss much that he would like to get. In a book that is necessarily so geographical, it seems unfortunate that no geographers were on the staff as advisers or contributors.

Yet all in all, the New Jersey Chamber of Commerce is to be commended for contributing so valuable a book. The volume is fine in appearance, its paper is of high quality, the printing is superb, the illustrations are carefully chosen, and the text is remarkably free from errors. Moreover, it is pleasantly instructive and crammed with facts. It is to be sincerely hoped that other states will soon follow New Jersey's excellent example and take stock of themselves.

LANGDON WHITE.

STRONG, ANNA LOUISE. *China's Millions*. xiv and 413 pp.; ills. Coward-McCann, Inc., New York, 1928.

China in revolution is China in upheaval, but not yet upsidedown, for the workers and peasants do not yet rule and oppress the upper classes. The advance is slow—a period of revolt, then a long period of brooding and adjustment to new ideas, until revolt breaks out anew, perhaps from so small a provocation as that "some girl in Hupeh cut off the hair of some old woman by force." Large, old, and unwieldy, China pushes herself forward in a series of convulsions to meet the changes inaugurated by a civilization younger by thousands of years. Too big, and for the present too ignorant, for all to assimilate the same ideas with the same understanding, China is a house divided against itself. South, Central, and North, while ultimately desiring the same end, find themselves fighting each other, treacherously agreeing, withdrawing, and waiting, until some event to all parties equally unexpected again sets the forces in motion.

Secrecy, ignorance, and wildest rumor make it difficult to obtain the truth about anything, especially when one is in the country for only a few months. Hence the author draws no conclusions, only states the facts as she saw them, and quotes often what she hears. Borodin, called in from Russia as adviser by the Chinese revolutionists, from "his constant, intelligent study of economic forces and social groups in China, interpreted by the light of many past revolutions," probably knew as much about the moves and motives of this revolution as anyone in China. The author of *China's Millions*, with Borodin's party on the way out of the country via Mongolia, writes: "Then Borodin, sitting on a camp stool in the orchard under a rising moon, gave to his Shensi comrade the most complete and leisurely exposition of the forces involved in China's revolution that I had yet heard him give. . . .

"'There were three forces at work,' he said. 'The big bourgeoisie in Shanghai and in other foreign concessions, whom Chiang Kai Shek tried to use for revolution; the smaller bourgeoisie of the inland Chinese territory whom Wang Ching Wei represented; and the organized workers and peasants. The big bourgeoisie can never unify China because they are not really against imperialists; they are allied with them and profit by them. The small bourgeoisie cannot unify China because they vacillate between the workers and peasants on the one hand and the big bourgeoisie on the other and, in the end, go over to the latter. The workers and peasants did not unify China because they trusted too much to the small bourgeoisie. . . .'"

Revolution and war pervade all China, but they have affected different parts differently. Chengchow was affected mainly by the commandeering of houses and the floods of paper money. Hankow, the chief industrial and commercial center for central China, seethed with labor leaders as well as with political and economic unrest. The peasants of Hupeh asked, and died, for "only the first step out of the bondage of feudal system." Hunan was "Red" not only from the peasants' revolution but from the reaction. Even Mongolia is struggling, by peaceful Russian methods, against six hundred years of peaceful oppression by the lamas, who still would continue the old-world isolation of Mongolia. Everywhere is the struggle for women's rights and workers' rights, emancipation from twelve to sixteen hours of labor with a bowl of rice for pay.

These are some of the events of the past—of the year 1927, whose summer the author spent in their midst. "The future," she says in the preface, "that is another matter. It will grow out of the experiences of the past year, when they have been properly digested by the tens of millions of Chinese who endured them. . . . Those experiences are the theme of this book, which deals consequently with the material out of which

the future will grow: the lives and struggles of workers, peasants, students, women, their individual concrete problems, their attempts to achieve organization and freedom, their measure of success and failure. . . ."

PRISCILLA H. WEBSTER.

RAMANN, E. *The Evolution and Classification of Soils.* Translation by C. L. Whittles, Ph.D. xii and 118 pp.; bibliography; index. W. Heffer and Sons, Ltd., London, 1928. Price, 7s., 6d., net.

Dr. Whittles' translation of one of the outstanding texts of the modern soil science deserves a warm welcome on the part of soil students throughout the English speaking countries.

Ramann's contribution to the literature of soil science is one of the finest, not only in that it embodies recent principles in soil classification and modern conclusions as to the processes of soil formation, but also in that it is shorn of all that laborious and heavy detail that makes many scientific works so difficult of digestion. It is trim, concise, and clear-cut, and truly represents the wheat from which the chaff has been separated; in short it is an excellent elementary text for the study of soils.

Some of the principles of modern pedology that are embodied in the book are: (1) The preponderant rôle played by climate in the soil-forming processes, as contrasted with the ancient notion of the character of the underlying rock as the chief determinant; (2) The important function of organisms in determining the character of the soil, as, for example, the marked effect of forest and grassland vegetation on the nature of their soils; (3) The classification of soils according to profile, or according to the stage of development as indicated by the nature of the horizontal layers or horizons, (a) *the soil*, (b) *the subsoil*, and (c) *the substratum*. A long chapter is devoted to the world distribution of soils based upon these modern classifications. The chapter headings are significant of the content: "Weathering," "Action of the Water Circulating in the Soil," "The Classification of Soils," "The Action of Organisms in the Soil," "The Climatic Soil Zones."

The translator has adhered to the German text as closely as possible. Where a slight deviation seemed to give a clearer rendering, the alteration has been noted.

The impression of the book is that of an excellent short elementary text for use in agricultural schools and colleges and for general reference.

CARLETON P. BARNES.

THOM, W. T., JR. *Petroleum and Coal, The Keys to the Future.* xviii and 223 pp.; maps, charts, and illustrations. Princeton University Press, 1929. $2.50.

A well-organized, clearly-presented digest of the essential facts relating to the effect of coal and petroleum upon the rise and development of modern civilization; the origin, occurrence, and utilization; and the magnitude and adequacy of the reserves of both minerals and their significance in future progress; this compact yet comprehensive volume has a real place on the shelf of every library, both public and private.

The twelve chapters into which the material of the book is divided are as follows:

Chapter I. Ancient history as an index to future influence of petroleum and coal upon national development and international relations.
II. Origin, composition, and classification of coal.
III. Relative importance and use of various ranks of coal.
IV. Coal fields of the world. Geologic age and geographic occurrence of coal.
V. Exploration and exploitation of coal deposits. Transportation of coal.
VI. Status of the coal-mining industry.
VII. Origin and occurrence of oil and gas.
VIII. Geologic occurrence of oil. Exploration for oil.
IX. Oil fields of the world.
X. The oil industry.
XI. Social importance of coal and oil. Present competitive status.
XII. Coal and oil reserves and the future of civilization.

Many an exhaustive treatise on coal or petroleum, much more ambitious and voluminous than this concise discussion, has less reference and educational value. Despite its condensed subject matter, it is written with such clarity and interest that it is easier to read than most scientific treatises. It is printed on good paper, in a clear font of type, and bound substantially. It constitutes a creditable example of press work and printing, as well as a noteworthy contribution to scientific literature.

W. ELMER EKBLAW.

COMBER, NORMAN M. *An Introduction to the Scientific Study of the Soil.* 187 pp.; tables; diagrams; bibliography; index. Edward Arnold and Company, London, 1927.

A text designed to meet the needs of students in agriculture, the book concerns itself not only with the development and classification of soils, but also with the application of their physical and chemical properties to plant growth. Considerable discussion of the chemical soil constituents, both organic and inorganic, and their relation to plant nutrition, is undertaken.

While more technical than Ramann's "Evolution and Classification of Soils," and, therefore, perhaps less suited to the purposes of the general reader or student, it has the advantage of containing discussion of the application of soil science. Many tables and diagrams representing

both qualitative and quantitative values of various soil properties are presented.

Chapter I, "The Soil and the Plant," introduces the student to some of the features of plant growth as related to the soil and discusses the new science of pedology. Chapter II discusses the mineral matter of the soil, with quantitative chemical analyses of soils derived from different parent material. Chapter III deals with organic matter in the soil, particularly humus, and treats its oxidation and its functions at some length. Chapter IV outlines the major soil forming processes. Chapters V to IX inclusive discuss the various physical properties of soil, size of particles, colloids, water, and temperature. Subsequent chapters are entitled "The Absorptive Properties of Soils," "Soil Nitrogen," "The Mineral Plant Food in Soils," "The Classification of Soils," "The Artificial Treatment of Soil," "The Literature of Soil Science and Its Use." Three appendices deal with colloid, capillarity, and the reaction of aqueous solutions.

CARLETON P. BARNES.

BELL, SPURGEON; WATKINS, RALPH J.; and others. *Industrial and Commercial Ohio.* Volume I. 168 pp.; 50 charts, 71 tables. Bureau of Business Research, College of Commerce and Administration, The Ohio State University, Columbus, 1928. $3.00.

It is only logical that the director of the Bureau of Business Research of a great state university should turn his attention to the problem of localization of industry within that state. Just so, Doctor Bell and his associates have begun a thorough study of the industrial and commercial situation in Ohio. And, logically, as the investigation proceeded, the influences of the geographical conditions became more and more evident. It was then that Professor C. C. Huntington of the Department of Geography at Ohio State University was asked to survey briefly the physical conditions that have affected greatly the localization of industrial and commercial establishments in Ohio, which has in the last few years been transformed from an agricultural into an industrial state.

This publication is replete with tables of statistical data compiled principally from the Division of Labor Statistics of the Department of Industrial Relations and from the Federal Census reports. Chapter I, "The Rank of Ohio among the Chief Industrial States," shows statistically and graphically the position of Ohio as a manufacturing state. In 1925 Ohio held third place with New York and Pennsylvania in first and second places respectively. A brief interpretative section accompanies the many tables and charts. Chapter II, "Ohio as an Industrial State," is a careful examination of the data of employment in order to discover the basis for Ohio's diversification in industry. Among the principal industries in 1925 the steel works and rolling mills paid more in wages and salaries than any other industry; stores, both retail and wholesale were second; foundry and machine shops, third; tires and tubes, fourth; and these four taken together made up approximately 32 per cent of the total payroll. Chapter III, devoted to the "Distribution and Concentration of Industrial Activity in Ohio," gives the data by counties both in tabular form and by cartograms. The latter method gives an excellent picture of the geographical distribution of industry and as usual the counties containing the large cities show the greatest employment. In the mining industry, however, the distribution of employment as based upon the payroll presents quite a different picture. The importance of the Appalachian Plateau section is due essentially to the presence of the coal and shale formations in the southeastern part of the State.

A characteristic feature of this publication is the use of many maps showing the localization of the various industries by counties. A more exact method would be desirable, but anyone familiar with the State of Ohio can readily interpret the maps. For example, the $90,000,000 payroll for Franklin County is in reality for the metropolitan district of Columbus. Chapter IV, "Fluctuations in Industrial Employment in Ohio, 1914–1926," presents in historical perspective the trends in industrial development. The indices of employment show the rise during the war period and the following year of 1919, the low level during 1921, and then the steady climb since the post-war slump to a level of relative stability. The index of employment of salespeople shows a characteristic resemblance to the index of all workers, but the marked seasonal fluctuations are evident. The tentative conclusion that the wide fluctuations in employment in certain counties is due to a lack of diversity in industry, in principle, is a sound generalization.

Chapter V, "The Natural Resources of Ohio," was written by Professor Huntington, and treats in the conventional manner such items as soil, topography, forests, water resources, annual rainfall, water power, stream pollution, mineral resources, natural gas, and petroleum. Remembering that this publication was prepared not alone for the professional economist but for a larger audience of practical business men, this geographical section is a simple explanation of significant physical conditions which influence both the concentration and the dispersion of industry. In 1920 not a single county within the glaciated area had a land value less than $45 per acre, and in the driftless area the value in every county averaged less than $45 and several below $25. One of the characteristic dot maps shows the widespread cultivation of corn, but there is a decided decrease in importance eastward from the center of the state. Wheat occupies a very similar area.

In the mineral industries clay products hold first place, followed respectively by coal, natural gas, petroleum, lime, and limestone. In the Akron area is mined a high-grade shale upon

which the important sewer pipe industry is based; and in southeastern Ohio the buff-burning clays associated with the coal measures have given rise to the manufacture of pottery and other ceramic products. Chapter VI, "The Population of Ohio in Its Relation to Industrial Employment," is an analysis of the shifts in population induced by the industrial transformation of the State. In Ohio, as in many other states, there has been a shift from the rural to the urban centers. Also, between 1910 and 1920, Ohio's negro population increased 67.1 per cent. The negroes have gone into the industrial districts where are to be found the greatest number of foreign-born whites, thus adding complications to an already difficult social problem.

If this splendid effort of Doctor Bell's could have been published in a more attractive form, it would have made a more impressive appeal to the business men of the State. The use of the Roto-press probably was not the deliberate choice of the director in preference to some other method. No doubt the use of the machine was an expedient because of necessary economies. Much of the current materials from this Bureau are reproduced in the same way.

The very nature of this publication suggests that continual revisions will be necessary to keep the tables down to date; and as the years go by, new interpretations of the data may be required. If the succeeding volumes and parts carry out the plans of the director, the finished work will be a comprehensive source of information about Ohio. It is regretted that the interpretations are not more extended, but, perhaps it is better that the detailed analyses of these data are left to other workers. Here the geographer as well as the economist will find a mine of useful information, from which may be made additional interpretations.

GUY-HAROLD SMITH.

LEPPAN, H. D. *The Agricultural Development of Arid and Semi-Arid Regions with Special Reference to South Africa.* 280 pp. Central News Agency, Ltd., South Africa, 1928. 8½ x 5 inches.

The author of this book is professor of Agronomy in the University of South Africa, and has written his honest opinion of agricultural possibilities in a fair and conservative manner. The first half of the book is devoted to the historical development of agriculture in South Africa, to the present condition of farming and its future possibilities, the physical factors and features of crop production, and to the animal industries.

Leppan states that the isohyet of 24 inches closely demarcates the maize belt in the Union and that 18–20 suffices only for an indifferent crop. Thus Bloemhof with an average rainfall of 18.26 inches for 22 years had 6 good crops, 5 indifferent crops, and 11 failures. Zeerust with 24.42 had 13 good, 5 indifferent, and 4 failures. Bethal with 30.19 in 21 years had 19 good and 2 indifferent crops. Only 35 per cent of the Union enjoys a rainfall of over 24 inches annually; 80 per cent of this area has its rainfall in the form of hard showers during a brief period in summer. Then the evaporation and run-off is high. The most important farming regions have rainfall either in winter or fairly evenly distributed. Perhaps 3,000,000 acres could be irrigated of which 1,390,000 acres were irrigated in 1921.

The wheat crop in the Union of South Africa (1921–1924) averaged 8,000,000 bushels and corn 57,200,000 bushels. Less amounts of barley, oats, and kaffir corn were grown. The yield of maize per acre was only 10.6 bushels and of wheat 8.6 bushels, as compared with 27.6 for corn and 15.9 for wheat per acre in the United States. Part of the small yield per acre results from unfavorable climatic factors and part from poor seed selection, lack of rotation of crops, and careless cultivation.

Even in animal industries, South Africa is handicapped by drought and the prevalence of diseases. During 1924–1925, according to official reports, 673,182 cattle died from disease, drought, and exposure, and 4,762,880 sheep and goats died from similar causes. In 1925 there were 9,738,000 cattle, 6,064,000 common goats, 2,272,000 Angora goats, 26,207,000 wooled, mostly Merino, sheep, and 4,783,000 non-wooled sheep. Dairying, pig raising, and poultry have not yet reached important degrees of production. The ostrich industry has suffered severely from the caprice of fashion, and the number of ostriches in the Union has declined from 776,000 in 1913 to 268,000 in 1922, and the value of feathers exported from £2,954,000 to £394,000. Feathers are now worth less than half as much per pound as in 1913.

Following the description of South Africa, Leppan next briefly describes agricultural areas elsewhere in the world where conditions resemble parts of the Union of South Africa, and he devotes a chapter to each of the following types: Bombay Presidency, Australia and arid or semi-arid United States. Next, he discusses the practices of dry farming and suggests crops and methods used successfully elsewhere that might be adopted by the South African farmer.

The author concludes that South Africa can never hope to be a great cereal-producing country and that its farming must remain predominantly pastoral in character. The book is an excellent treatise on a topic of outstanding importance to South Africa.

O. W. FREEMAN.

WARSHOW, H. T. *Representative Industries of the United States.* xiii and 702 pp.; illustrations, charts, diagrams, appendix, bibliography, and index. Henry Holt and Company, New York, 1928. 9 x 6 inches. $5.00.

Representative Industries of the United States, written by a number of leaders in their respective

fields and edited by H. T. Warshow, Comptroller, National Lead Company, is a valuable contribution to industrial and economic studies.

In this volume is presented the masterly work of twenty-one authors dealing with a few of the important industries of the United States. "It is to these men—the leaders in industry—to whom we must look for the most competent exposition of the difficulties and growth of individual American industries," says the editor in the preface. The scope of the field covered and the leaders in the several industries may best be presented by listing the chapters: "The Aluminum Industry" by Robert J. Anderson; "The Automobile Industry" by A. R. Erskine; "Banking in the United States" by H. Parker Willis; "Chemical Industries" by Henry Wigglesworth; "The Construction Industry" by W. C. Clark; "The Copper Industry" by F. E. Richter; "The Cotton Industry" by C. T. Revere; "The Electric Industry" by L. A. Osborne; "The Iron and Steel Industry" by Marshall T. Jones; "Lead Mining and Smelting in the United States" by H. T. Warshow; "The Blue Lead and Mixed Metal Industry" by J. R. Wettstein; "The Leather Industry" by Allen Rogers; "The American Meat-Packing Industry" by Rudolf A. Clemen; "The Lumber Industry" by R. C. Bryant; "The Paint Industry" by R. L. Hallett; "The American Petroleum Industry" by George Ward Stocking; "The History of Railway Equipment" by William H. Woodin; "Rubber" by P. W. Litchfield; "The Water Power Industry" by Frederick Darlington; "The Wool Industry" by Max W. Stoehr; "The Zinc Industry" and "The Non-Ferrous Metal Statistics" by W. R. Ingalls.

The treatment of the various industries is well summarized by the editor in the preface: "The contributions follow a uniform outline and cover in a general way a brief history of the industry, the conditions surrounding its origin in the United States, its relation to American industry as a whole, the growth of its domestic trade, the improvements in technological processes, the growth of its export business, a discussion of its labor problems, a brief history of large consolidations or combinations, and any special developments peculiar to the individual industries."

This book is in no sense a geography textbook, nor is it written by geographers, but a wealth of material is presented that will be heartily welcomed by the economic and industrial geographer. Furthermore, it is a book that anyone interested in economic and industrial studies may consult with much profit.

FLOYD F. CUNNINGHAM.

HAMLIN, SCOVILLE. *Waste Not—Want Not.* 224 pp.; table of contents; bibliography; charts. Dorrance and Company, Inc., Philadelphia, 1928. $2.00.

In his preface to the 1910 edition of *The Conservation of Natural Resources in the United States*, C. R. Van Hise said:

"It is my hope that this book may serve a useful purpose in forwarding the great movement for conservation which, as it seems to me from the point of view of the not distant future of the human race, is more important than all other movements before the people."

His hope was fulfilled and his splendid work is being carried forward by many disciples.

Eighteen years later appears *Waste Not—Want Not* by Scoville Hamlin. But, whereas Van Hise's treatment might aptly be called *geographic*, Hamlin's must certainly be considered *economic* and *political* with geographic nuggets sprinkled here and there at strategic points. Whereas the work of the latter deals with that in the United States in its relation to the rest of the world, the work of the former deals essentially with the problem in the United States. Thus, the two books supplement each other remarkably well. The thread of thought pervading the whole volume may be summed up in the following paragraph:

"The nations can stabilize production through meeting the cost of upkeep of the resources employed in advance of expansion. They can substitute the income incentive for the profit incentive."

Waste Not—Want Not consists of nineteen chapters of which the following six will be found to be extremely interesting and valuable to geographers:

I. The New Basis of Subsistence
II. Machines and Unemployment
III. "Rational Organization" of the Coal Industry
V. Conservation of Natural Resources
VI. Growth of Trade Welding Nations
XVII. Permanent Quota Basis for Control of Immigration

Mr. Hamlin points out that so long as the earth's population was small and most of the people lived close to a bare margin of subsistence, the drain on natural resources was insignificant. Then, referring to Dr. C. K. Leith for his authority, he makes the amazing statement that the world has mined more of its resources in the last two decades than during all preceding time. If the oriental countries emulate their occidental neighbors in exploitation and conquest, the world's high-grade resources will be short-lived, indeed. If China should exploit her coal and iron at the rate prevailing in the United States, she would exhaust them in less than a century.

The author handles the American coal problem admirably. America's consumption amounts to about 600,000,000 tons *per annum*, but the capacity of her coal companies is double this, and the industry is overmanned by approximately 200,000 miners. The average reader would probably blame the government on the one hand and the operators on the other for this dilemma. But Scoville Hamlin blames the *public*, saying:

"As long as the public is determined to obtain its coal at the lowest possible price, regardless of the waste attending irregular employment; regardless of the use of coal for pillars in the mines, regardless of the waste involved in leaving the poorer veins to be extracted at some future date at enormous expense, it will pay to market our coal resources as quickly as possible."

While the treatment of the English fuel problem is brief, it is excellent. More than half the English coal is being mined at a loss, which is consequent in large part upon deep mining. Whereas the average depth of a shaft in the United States is 260 feet, in England nearly one-half the coal is mined at a depth of a sixth of a mile. At the present rate, England's coal resources would be expected to last little more than 500 years.

All in all Mr. Hamlin has written a timely and valuable book. While he attacks most vigorously many of our governmental policies, he does so with authority and common sense. His criticism is persistently constructive.

The book will challenge every reader. At present the average person has little conception of *his* responsibility regarding the elimination of waste. Consequently, such a book as *Waste Not—Want Not* will, if it has a wide enough sale, go far in correcting this situation.

LANGDON WHITE.

ANNOUNCEMENT

DR. CLARENCE F. JONES has recently returned from South America after having assembled authoritative data, and studied conditions in the field, for the completion of his series on the *Agricultural Regions of South America*. His series is resumed in this issue.

Due to the difficulty of assembling and interpreting statistics for part of his regions, the next instalment of Dr. O. E. Baker's series on the *Agricultural Regions of North America* has been postponed until a later issue.

Agricultural Regions of Africa, by Homer L. Shantz of the University of Illinois and president-elect of the University of Arizona; *of Australia*, by Griffith Taylor of the University of Sidney, one of the foremost geographers of the world; and *of Asia*, by Olof Jonasson of the University of Commerce of Stockholm will follow in later issues to complete the finest geographic discussion of the world's agriculture thus far published.

To obtain the complete series of these extremely valuable articles, which present for the first time on such a comprehensive and accurate basis the significant divisions of the world's most important industry, it will be necessary to subscribe at once for ECONOMIC GEOGRAPHY, and date back to the October, 1926, issue.

In addition to this series of articles on agriculture, other series are being initiated; every issue will also contain four or five articles dealing with urban and regional geography, with problems of land utilization, with programs of development of resources, with commerce, with transportation, with health, and with the hundred and one other subjects that are of present geographic interest, all by the most competent and best informed authorities in their respective fields. ECONOMIC GEOGRAPHY is indispensable to the intelligent citizen.

The subscription price to all new subscribers in the United States and possessions is $5.00 the year or $9.50 for two years. To all foreign countries, $5.50 the year or $10.00 for two years.

ECONOMIC GEOGRAPHY

A QUARTERLY journal of ECONOMIC GEOGRAPHY published by Clark University for the benefit of geographers, economists, teachers, professional and business men, and all who are interested in the intelligent utilization of the world's resources.

Subscription rates are $5.00 the year in the United States and its Territories; $5.50 the year beyond the borders of the United States, except to charter subscribers.

Only a limited number of the first numbers of ECONOMIC GEOGRAPHY are available.

The January issue of Volume 5 contains the following articles:

Industrial China, H. F. James, Wharton School of Finance and Commerce.
Land Resource Inventory in Michigan, Carleton P. Barnes, Michigan Land Economic Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Scranton's Industrial Integrity, Clifford M. Zierer, University of California at Los Angeles.
A Critical Situation in Two One-Crop Wheat Farming Districts in California, John W. Coulter, University of Hawaii.

The October issue of Volume 4 contains the following articles:

Fisheries of the South Atlantic and Gulf States, J. H. Matthews, Atlantic Coast Fisheries Company.
The Iron and Steel Industry of the Birmingham, Alabama, District, Langdon White, Randolph-Macon Women's College.
America's Resources in Nitrogen, Potash and Phosphorus, Guy E. Mitchell, U. S. Geological Survey.
Possibilities of Rubber Production in Caribbean America, Jewell Venter, University of Missouri.
The Kentucky Geographical Surveys: A Review, W. Elmer Ekblaw, Clark University.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.

July includes:

The Civilizing Rails, Mark Jefferson, State Normal School, Ypsilanti, Michigan.
Piedmont North Carolina and Textile Production, Jefferson Bynum, University of North Carolina.
Location Factors in the Iron and Steel Industry, Richard Hartshorne, University of Minnesota.
The Ozark Orchard Center of Southern Illinois, Ina C. Robertson, State Teachers College, Valley City, North Dakota.
Agricultural Regions of South America, Clarence M. Jones, Clark University.
Egypt is the Nile, Paul F. Gemmill, University of Pennsylvania.

April includes:

Iron and Steel Industry of the Pittsburgh District, Langdon White, Miami University.
European Forests and Their Utilization, Bruno F. A. Dietrich, University of Breslau.
Agricultural Regions of South America, Clarence F. Jones, Clark University.
Localization of the Cotton Industry in Lancashire, England, Rollin S. Atwood, Clark University.
New York Barge Canal—Expectations and Realizations, Florence Whitbeck, University of Rochester.

January includes:

Agricultural Regions of South America, Clarence F. Jones, Clark University.
The Red Land of Gwent in Eastern Monmouthshire, E. Muriel Poggi, University of Illinois.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Cotton Manufacturing—North and South, Robert M. Brown, Rhode Island College of Education.
Distribution of Crops in Peru, Harley P. Milstead, Montclair College of Education.

The October issue of Volume 3 contains the following articles:

The United States and Its Chief Competitors in South American Trade, Clarence F. Jones, Clark University.
A Nation's Water Power, Herman Stabler, U. S. Geological Survey.
Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Relation of Taurine Cattle to Climate, Fred A. Davidson, University of Illinois.
The Michigan Sugar Beet Industry, F. A. Stilgenbauer, College of the City of Detroit.
The Cotton Industry of Peru, Arthur H. Rosenfeld, Tropical Plant Research Foundation, and Clarence F. Jones, Clark University.

Single copies of back numbers of Volumes 1 and 2, 1925 and 1926, will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volume 3, 1927, and Volume 4, 1928, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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